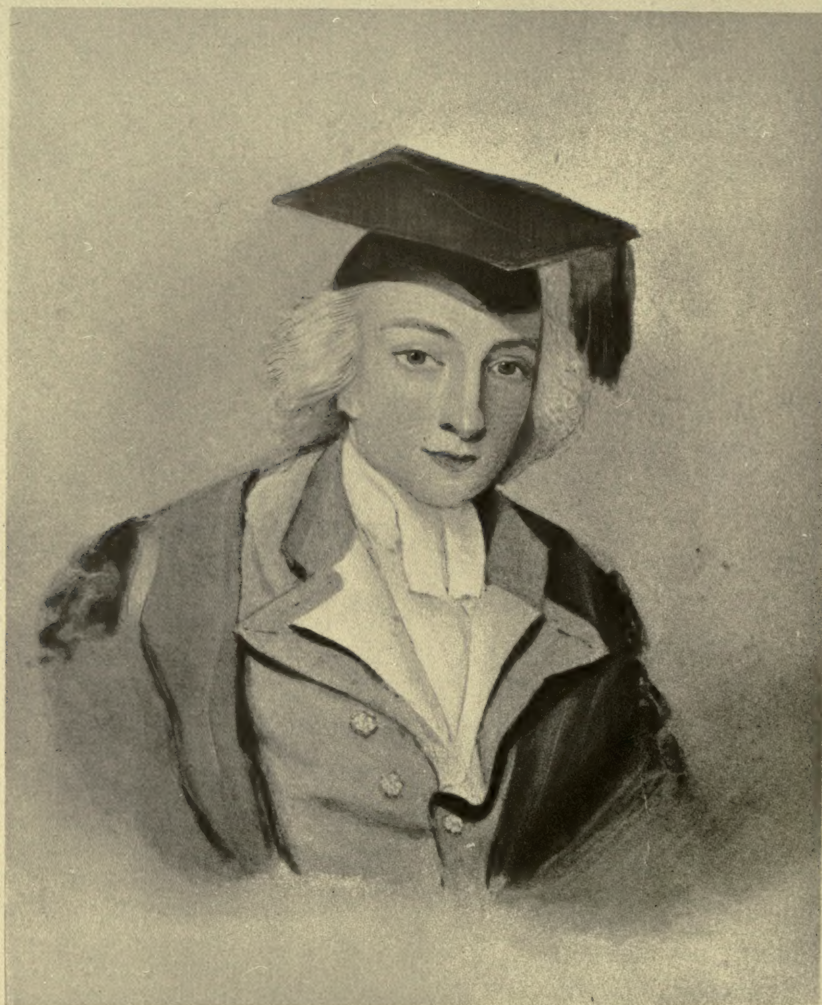

THE SMITHSONIAN INSTITUTION

1846—1896

The History of its First Half Century

Edited by

GEORGE BROWN GOODE

CITY OF WASHINGTON
1897

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HISTORY OF
THE SMITHSONIAN INSTITUTION

PREFACE

In 1796, George Washington, in his farewell address to his fellow-countrymen, said: "Promote, then, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened." Thirty years later an Englishman, James Smithson, as though influenced by these words, bequeathed the whole of his property to the United States of America in trust "to found at Washington an establishment for the increase and diffusion of knowledge among men." John Quincy Adams, in presenting to the National House of Representatives the first report of the Select Committee on the message of the President announcing the Smithson Bequest, exhorted his colleagues in these words: "Let the trust of James Smithson to the United States of America be faithfully executed by their representatives in Congress; let the result accomplish his object: 'the increase and diffusion of knowledge among men.'"

The Act of Congress establishing the Smithsonian Institution was signed by President Polk on August 10, 1846, and on September 7 the Board of Regents held its first meeting. The past year marks the close of the first half century of the operations of the Institution. This volume presents the story of the realization of one of the desires of Washington, through the will of Smithson, the wise legislation of Congress, and the devotion of those upon whom the management of the Smithsonian Institution has devolved.

WILLIAM McKINLEY.

The Executive Mansion,
Washington, June 22, 1897.

INTRODUCTION

The law establishing the Smithsonian Institution was signed by President Polk on August 10, 1846, and the first organic act of the Institution was a meeting of the Board of Regents, held on September 7 of that year. As far back as 1893, in view of the approaching completion of the first half century, I discussed with the Executive Committee of the Regents the best method of celebrating this event.

It seemed quite impracticable to arrange for a gathering of delegates from other scientific institutions, such as is often held on similar occasions by institutions and learned bodies, and the simplest and most effective means of commemorating it appeared to be the publication of a suitable volume, which would give an account of the history, achievements, and present condition of the Smithsonian Institution.

Doctor G. Brown Goode, whose acquaintance with its history was unrivaled, drew up a comprehensive plan for the volume, and on its approval, Doctor James C. Welling, a Regent, agreed to undertake its editorial supervision. Doctor Welling's death seemed to put a stop to the proposed work, for there appeared to be no one sufficiently acquainted with the history of the Institution who had the ability, the willingness, and the leisure to assume this very considerable task. It was then that Doctor Goode told me of his great desire to undertake the work. Knowing how numerous his duties already were, I at first refused, and it was only at his earnest solicitation that I agreed to his request.

The manuscript was so far advanced at the time of his death as to render possible its completion for the press, and its publication upon the lines he laid down. He had not only written many of the chapters, but had made arrangements for the illus-

trations and other details of the book. Though this lamented event has delayed its appearance, I have been enabled to secure the aid of valued assistants who have carried the work through. I have added to the original plan a biographical sketch of Doctor Goode, by Doctor David Starr Jordan, President of the Leland Stanford Junior University.

S. P. LANGLEY,
Secretary.

Smithsonian Institution,
Washington, June 23, 1897.

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JAMES SMITHSON

By Samuel Pierpont Langley

THE founder of the Smithsonian Institution was known in his earlier years as James Lewis Macie, his mother, Elizabeth Keate Macie, being at the time of his birth, in 1765, the widow of James Macie, a country gentleman of an old family resident at Weston, near Bath. She was of the Hungerfords of Studley, a great-grandniece of Charles, Duke of Somerset, through whom she was lineally descended from Henry the Seventh, and was cousin of that Elizabeth Percy who married Hugh Smithson (who later became Duke of Northumberland, and by act of Parliament took the name of Percy).

An unverified story represents Smithson's mother as at one time hoping to have contracted a marriage with the Duke of Northumberland, and seeking, for that purpose, a divorce from her husband, which he successfully opposed; but, in any case, the subject of our sketch, who only apparently after his mother's death applied to the Crown for permission to take the name of Smithson, describes himself in his final will as "son to Hugh, first Duke of Northumberland, and Elizabeth,

heiress of the Hungerfords of Studley, and niece of Charles, the proud Duke of Somerset."

We need not, then, practise a reticence which Smithson himself did not desire to observe, especially since the facts are already public. There is, indeed, the further reason that it is especially to these facts that the foundation which bears his name is due, for Smithson always seems to have regarded the circumstances of his birth as doing him a peculiar injustice, and it was apparently this sense that he had been deprived of honors properly his which made him look for other sources of fame than those which birth had denied him, and constituted the motive of the most important action of his life, the creation of the Smithsonian Institution.

By the student of human nature every man's conduct is judged in reference to its determining motives, and if we try Smithson's from the point of view of his own time, not of ours, we shall not judge too hardly the fact that the circumstances of his birth and his feeling that he was by right a Northumberland and a Percy were a subject of pride to him as well as of pain. He once wrote:[1]

"The best blood of England flows in my veins; on my father's side I am a Northumberland, on my mother's I am related to Kings,[2] but this avails me not. *My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten.*"

It has been wondered that Smithson should have left his fortune for the purpose he did, but not by those who have considered the sentence placed here in italics, where we surely

[1] Rhees's "Smithson and his Bequests." "Smithsonian Miscellaneous Collections," volume XXI.

[2] Doctor Goode pointed out in his "Account of the Smithsonian Institution," written for the Atlanta Exposition, that: "Smithson was of royal descent, through his maternal ancestor, the ill-fated Lady Jane Grey, great-granddaughter of King Henry VII, grandniece of Henry VIII, and cousin of Elizabeth. His ancestor in the ninth generation, Edward Seymour, the first Duke of Somerset and Protector of England, was the brother of Queen Jane Seymour and the uncle of King Edward VI."

scarcely need to read between the lines to see the genesis of the institution which perpetuates the name he bore, in place of the titled one he was denied.

It will be observed from facts given later that it was only under circumstances which showed that he had no right to the name of Macie (which seems to have been first imposed upon him under circumstances which left him free to change it) that he in later life had that of Smithson, to which he had every moral right, legally confirmed to him. After pointing out that the change was obtained under circumstances which do him no discredit, we are chiefly concerned with this sense of the injustice under which he labored from its after results; for if the kind of pride which dictated the first sentence I have above quoted be one which, from the point of view of the present day, attracts little sympathy, we can feel more with the worthier spirit which resulted from it, and in which he wrote the second. We are in no ways concerned with the ancestral honors or titles of the Percys, as such; but if there be anything in heredity, we may supplement our limited knowledge of him by some consideration of that very remarkable man, the first Duke of Northumberland, whose child Smithson declared himself to be, and undoubtedly was; for the father was remarkable, not in having been born great, but in having achieved greatness,— at least a greatness of that sort which his less fortunate son must always have envied him.

Hugh Smithson, the father of the founder of the Smithsonian Institution, was the son of Langdale Smithson, who, according to another unverified tradition, occupied for a time the then relatively unconsidered position of a medical practitioner. The Smithsons, however, were an old family, which was, in fact, remotely connected by lineage with the Percys. As country gentlemen they were reared in the habit of person-

ally managing their estates; and, notwithstanding his culture and his refined and artistic tastes, the business aptitude of his race was strong in Smithson's father.

The entertaining story of his courtship of the granddaughter of "the proud Duke" of Somerset is told in the "Annals of the House of Percy," and it is not necessary to repeat it here further than to remark that in it, as in everything else, he showed the tact, persistence, and ability which raised him from the position of a private gentleman to one of the first dukedoms of England at a time when such a transition was regarded as transcending all possibility, and became the subject of wonder after it had happened.

As a landlord, Sir Hugh Smithson (as he afterwards became)[1] had been conspicuous for good management. After his marriage to the heiress of the Percys he restored Alnwick Castle, and lived there so expensively that Horace Walpole wrote of the new groom and bride that they would soon have no estate left; but the prophecy was falsified by the marked ability of the future Duke, who, though he continued to maintain what was even then considered magnificent state, showed such extraordinary administrative capacity as enabled him not only to keep undiminished but to very greatly increase the important possessions which became his wife's after their marriage; for at the date of Sir Hugh Smithson's marriage, in 1749, the rent rolls of Alnwick Castle amounted to £8,607, while in 1778 they had increased to £50,000, and all this while a liberal and even magnificent scale of expenditures appears to have been adopted.[2]

If he be a benefactor to mankind who makes two blades of grass grow where one grew before, then the new Lord of

[1] He succeeded to the title of Baronet on the death of his grandfather, Sir Hugh Smithson, which took place in 1729.

[2] See "Annals of the House of Percy," by Edward Barrington de Fonblanque, London, 1887, Volume II, page 531, and Appendix XXVI.

Northumberland did indeed entitle himself to the gratitude of those within the influence of his kindly rule.

"He found the country almost a desert," says the Bishop of Dromore, "and he clothed it with woods and improved it with agriculture."[1] For more than twenty years he is said to have planted annually over twelve hundred trees; he imported specimens of hitherto unknown timber, fruits, and flowers from various parts of the world, and expended large sums not only in the reclamation and drainage of lands, but in the improvement of the dwellings of his laborers, at a time when the physical comfort or moral well-being of the poor rarely occupied the thoughts of the lords of the soil.

He showed a like ability in his dealings with the Crown, which procured him the unprecedented step from the baronetcy to the dukedom, and in every part of his life (with which we are not further concerned here) he showed himself an exceptionally able man.[2]

American history and poetry remember his son, the half-brother of Smithson, who—

> "Fought for King George at Lexington,
> A Major of Dragoons,"[3]

[1] See "Annals of the House of Percy," by Edward Barrington de Fonblanque, London, 1887, Volume II, page 531, and Appendix XXVI, citing Collins's [Peerage] 5th edition.

[2] The Duke showed the independence of his character, as well as the soundness of his judgment as a statesman, by opposing the party in power upon the question of war with the Colonies, obtaining leave of absence for his son, Lord Percy, who was ordered to America. Of this, however, Lord Percy refused to avail himself, contending that he could not at such a juncture withdraw. He accordingly embarked for Boston in the spring of 1774, and his journal and letters during the succeeding years throw light upon many of the incidents of the struggle.

[3] The fact that the heir of the house of Percy commanded the force of the British troops which saved the retreat from Concord made a strong impression upon the fathers of New England who fought on the memorable day, and is often mentioned. This association of the story of the defeat and pursuit of the British troops with the name of Percy, in the minds of the rustic victors, is alluded to by Lowell:

> "Old Joe is gone, who saw hot Percy goad
> His slow artillery up the Concord road . . .
> Had Joe lived long enough, that scrambling fight
> Had squared more nearly with his sense of right,
> And vanquished Percy, to complete the tale,
> Had hammered stone for life in Concord jail."

and who, it might be added, saved to the King the remnant of his forces, which, without Percy's timely succor, would have been utterly destroyed. As an indication of family traits, it may be interesting to note the memorable action of the half-brother of Smithson, and his modest description of it.

General Gage had placed him in command of the camp formed at Boston, whence he writes to his father on July 5, 1774:

"As I cannot say this is a business I very much admire, I hope it will not be my fate to be ordered up the country. Be that as it may, I am resolved cheerfully to do my duty as long as ever I continue in the service. If I do not acquire any degree of reputation in it, it will be my misfortune, but shall never be my fault."

Throughout the ensuing winter he remained in the camp around Boston, whence on April 20 he writes to inform his father of that first bloodshed which was the prelude of the War of the Revolution:

"I was ordered out yesterday morning to cover the retreat of the Grenadiers and Light Infantry who had been sent upon an expedition up the country.[1] I had with me my brigade and two pieces of cannon. We met them at a town[2] about fifteen miles off, sharply attacked and surrounded by the rebels, and having fired away all their ammunition, I had the happiness of saving them from inevitable destruction, and arriving with them at Charlestown, opposite Boston, at eight o'clock last night; not, however, without the loss of a great many, having been under an incessant fire for fifteen miles. The rebels, however, suffered much more than the King's troops. I have not myself received even the least scratch, and I beg that you will not either of you be uneasy on my account."[3]

1 The memorable expedition to Concord, which gave rise to the battle of Lexington.

2 Lexington.

3 "Annals of the House of Percy," Volume II, page 552.

Lord Percy was too good a soldier to fall into the error of despising his enemy. He had never shared in that contemptuous estimate which Englishmen, ignorant of the country and its population, had formed of the military capacity of the American colonists, and which had led the King, under the prompting of such advisers as Lord North and Lord George Germain, to declare that all resistance would collapse on the first menacing advance of half a dozen English regiments.

"Whoever," he writes to his father, "looks upon them as merely an irregular mob will find himself much mistaken; they have men amongst them who know what they are about, having been employed as rangers against the Canadians and Indians . . . nor are their men devoid of the spirit of enthusiasm, as we experienced yesterday, for many of them concealed themselves in houses and advanced within ten yards to fire at me and the other officers, though they were morally certain of being put to death themselves in an instant."

The father died in 1786, and was buried in Westminster Abbey, where he is described as "the most high puissant and most noble prince Hugh Percy, Duke and Earl of Northumberland, Earl Percy, Baron Warkworth and Lovaine, Lord Lieutenant and Custos Rotulorum of the Counties of Middlesex and Northumberland and of all America, one of the lords of His Majesty's most Honourable and Privy Council and Knight of the most noble Order of the Garter, etc., etc., etc."; but we are here concerned with these honors only as an evidence of the character of the man who did not inherit, but who conquered them by the force of his will.

Let us, after noting the essential qualities of his race in the father and brother, return to the immediate subject of our memoir, the date of whose birth is fixed by the Pembroke College record as 1765. His mother, Elizabeth Hungerford

Keate (Macie), is described in the will of Penelope Keate, grandmother of Smithson, in a bequest dated July 13, 1764, as "my daughter, Elizabeth Macie, of Bath, widow," so that at this time her husband was already dead. This fact, only recently ascertained, is important in the estimate it leads us to put on one of the principal actions of Smithson's life, his taking of his father's name instead of that of Macie, by which he was previously known.

Something of the facts of the young man's birth were generally surmised, and we shall see that he was apparently not allowed as a youth even to describe himself as Macie's son, a thing to be remembered in connection with his subsequent action in taking the name of Smithson.[1]

There has been found no record of the Macies at Weston in the years preceding his birth; there is no reference to him in the accessible archives of the Northumberland family, nor do we know more of the subsequent circumstances of his mother than that she inherited the property of the Hungerfords of Studley in 1766, on the death of her brother, Lumley Hungerford Keate,—a matter of interest as indicating the probable source of a considerable portion of the Smithson bequest.

We have after this no knowledge of the founder of the Institution until his name is entered in 1782 as James Lewis Macie, a Gentleman Commoner, at Pembroke College, Oxford, but entered in a way which, as the copy of the record indicates, omitted the prescribed form of stating the name of the father, which others were obliged to comply with.

He was at this time but a lad, and as we are assured only

[1] In 1880, when Mr. Rhees's memoir was prepared, the date of Smithson's birth, obtained from an erroneous inscription on his tomb, was 1754, which would have placed it eleven years earlier than the actual event, during the married life of Mr. and Mrs. Macie, and put a less favorable construction on young Macie's action in taking the name of Smithson from that it bears, under the circumstances which are now for the first time detailed.

very powerful influence could have procured permission for this departure from rule, we may presume that his action, whether acceptable or not to him, was dictated by an authority to which he had in any case to yield.

In 1894 I ascertained through the kindness of Chester Waters, Esquire, that Reverend Frederick Brown had occupied himself during a large part of his life with the biographies of the Hungerford family, and learned from his surviving daughter that his manuscript was deposited in the British Museum. This manuscript (which is numbered 33,412), I, with Doctor Cyrus Adler, spent some time in examining, with the results here given. Among other facts I learned that Smithson was born in France, and was brought to England for his education, and naturalized. I further was fortunately led to consult the Oxford records, which show that he in his early years entered as a Gentleman Commoner at Pembroke College, where he matriculated in 1782, his age then being given in the registry, here appended,[1] as seventeen, so that this matriculation record shows him to have been born eleven years *later* than was supposed. This is material, for it will be seen from what has preceded that his memory is thus cleared of the imputation under which it at one

[1] Coll: Exon: 25º Carolus Ofspring Blackall 17 Theophili de Dodbrooke Com: Danmon: Cler: Fil:

Coll: Wad: 26º Robertus Harbin 17 Swayne de Newton Com: Somerset: Arm: Fil: Maii 1º

Coll: Hert: Gulielmus Bragge 17 Joannis de Dillington Com: Somerset: Arm: Fil:

Coll: Wadh: 2do Joannes Higgins 19 Joannis de Dicheatt Com: Somerset:—— Gen: Fil:

Coll: Mert: 3º Henricus Lloyd 18 Erasmi de Civitate Vigorniensi Gen: Fil:

Coll: Di. Jo. Bap. 4º Thomas Keck 17 Samuelis de Civitate Londin:—— Gen: Fil:

changed to Smithson

Coll: Pemb: 7º Jacobus Ludovicus Macie 17 de Civit: Londin:—Arm: Fil:

Coll: Ball: 8º Hon. Archibaldus Cathcart 18 Caroli de Aloa Com: Clackmanan: Baros Fil

Coll: Di: Jo: Bap. 9º Thomas Dethick 17 Thomae de Bombay apud Ind: Orient: Arm: Fil

Coll: On: Nas: 10mo Arthurus Townson 18 Joannis de Bentham Com: Eboracensi—— Pleb: Fil

Coll: Christi 10mo Calverley Joannes Bewicke 17 Benjamin de Clapham Com: Surriae Gen: Fil:

Coll: Magd: 11º Isaacus Williamson 21 Josephi de Withburn Com: Cambr: Gen: Fil:

time seemed to rest, of his having adopted the name of Smithson in circumstances where a son should have remained silent.

We have also an authentic contemporary portrait of him in the dress of an Oxford student, here reproduced, which, it is interesting to observe, confirms the age thus given, by representing him as a mere youth.

Nothing material is remembered of his life at the college, except a tradition that he was the best chemist and mineralogist of his year, though in his journal, when but a youth of nineteen, he gives a description of a geological tour in 1784 through Oban, Staffa, and the western islands, in company with De St. Fond, "the celebrated French philosopher," and the Italian Count Andrioni, in which he carried on observations on the methods of mining and manufacturing processes, made with all the minuteness which the conditions of the journey permitted. The journal indicates that the tour at that time was undertaken, if not at any considerable risk, yet not without a considerable amount of privation and self-denial, such as would not be met by the modern traveler, and shows that he was far more occupied with science than with the ordinary pleasures of so youthful a tourist. We learn also that the young student was noted for diligence, application, and good scholarship, attracting attention by his proficiency in chemistry, then a novel study, while his vacations were ordinarily passed in such excursions as that just referred to, and devoted to the collection of minerals and ores, which it was his favorite occupation to analyze. At Oxford, then, at a time when the study of physical science was almost unknown in the University, he appears to have already conceived that devotion to scientific research which characterized all his future life.

He was graduated at Pembroke College, with the degree

of Master of Arts, on May 26, 1786, as James Lewis Macie, and admitted as a Fellow of the Royal Society on April 26, 1787, on the following recommendation:

"James Lewis Macie, Esq., M.A., late of Pembroke College, Oxford, and now of John Street, Golden Square,—a gentleman well versed in various branches of Natural Philosophy, and particularly in Chymistry and Mineralogy, being desirous of becoming a Fellow of the Royal Society, we whose names are hereunto subscribed do, from our personal knowledge of his merit, judge him highly worthy of that honour and likely to become a very useful and valuable Member.

RICHARD KIRWAN,
C. F. GREVILLE,
C. BLAGDEN,
H. CAVENDISH,
DAVID PITCAIRN."

Cavendish, whose name appears here, was the eminent physicist, and, as we learn elsewhere, was an intimate friend.

Smithson's lodgings were for some time in Bentinck Street, where Gibbon wrote much of his "Decline and Fall of the Roman Empire." Here he apparently prepared his first scientific paper, which was signed James Lewis Macie, and was read on July 7, 1791, before the Royal Society. It is entitled "An Account of Some Chemical Experiments on Tabasheer."[1] We learn of him incidentally in 1792 as journeying from Geneva to Italy through the Tyrol, and find him in the same year in Paris writing from the Hôtel du Parc Royal, Rue de Colombier, a letter in which he expresses sentiments which represented what would have been then called advanced Jacobinism. "*Ça ira*," he says, "is growing the song of England, of Europe, as well as of France.

[1] *Philosophical Transactions of the Royal Society of London*, Volume LXXXI, part II, page 368.

Men of every rank are joining in the chorus. Stupidity and guilt have had a long reign, and it begins, indeed, to be time for justice and common-sense to have their turn . . . the office of king is not yet abolished, but they daily feel the inutility, or rather great inconvenience, of continuing it, and its duration will probably not be long. May other nations, at the time of their reforms, be wise enough to cast off, at first, the contemptible incumbrance." Smithson here shares the opinion of a large and influential portion of Englishmen of the time in which he wrote, but the excesses of the French Revolution, which immediately followed, caused a general revulsion of feeling, and it would not be fair to argue from this youthful expression as to his maturer judgment.

The date of his application to the Crown for permission to take his father's name has not been ascertained, but in the will of his half-sister, Dorothy Percy, he is referred to as "Macie" in 1794 (eight years after his father's death). The name of Smithson is first certainly known to have been used by him in connection with his second communication to the Royal Society, "A Chemical Analysis of Some Calamines,[1] by James Smithson, Esquire," read November 18, 1802.

In this paper the author remarks that "Chemistry is yet so new a science; what we know of it bears so small a proportion of what we are ignorant of; our knowledge in every department of it is so incomplete, consisting entirely of isolated points, thinly scattered, like lurid specks on a vast field of darkness, that no researches can be undertaken without producing some facts leading to consequences which extend beyond the boundaries of their immediate object."

The Abbé Haüy had advanced the opinion that calamines were all mere oxides or "calces" of zinc. Smithson's analysis completely overthrew this opinion, and established these

[1] *Philosophical Transactions*, Volume XCIII, page 12.

minerals in the rank of true carbonates, while his remarks on the action of the ores of zinc before the blowpipe evince much discernment; and the paper, on the whole, is altogether a creditable one.[1]

At this period he seems to have ceased his contributions to the Royal Society, and later we find his name more frequently in the "Annals of Philosophy," a journal of high character, where there is a communication from him dated Paris, May 22, 1819, on "Plombe gomme," and about the same time a paper on a native sulphuret of lead and arsenic, with numerous other papers, among which is one in 1822, "On the Detection of Very Minute Quantities of Arsenic and Mercury," where he contributed a method which was generally used by chemists until quite modern tests superseded it. The papers[2] in all number twenty-seven, of which eight here cited were published in the "Philosophical Transactions of the Royal Society," between the years 1791 and 1807, one in the "Philosophical Magazine" in 1807, and eighteen in "Thomson's Annals of Philosophy," between 1819 and 1825, and these all give the idea of an assiduous and faithful experimenter, an impression enlarged by the last one of the series, bearing date of June, 1824, which contains some observations on the formation of the Kirkdale Cave, forcibly

[1] Smithson's subsequent communications to the *Philosophical Transactions* are six in number:

"An Account of a Discovery of Native Minium," submitted in a letter dated from Cassel, in Hesse, March 2, 1806. (Volume XCVI, part I, page 267.)

"On the Composition of the Compound Sulphuret from Huel Boys, and an Account of its Crystals," 1808. (Volume XCVIII, page 55.)

"On the Composition of Zeolite," 1811. (Volume CI, page 171.)

"On a Substance from the Elm Tree, called Ulmin," 1813. (Volume CIII, page 64.)

"On a Saline Substance from Mount Vesuvius," 1813. (Volume CIII, page 256.)

"A few Facts relative to the Coloring Matter of Some Vegetables," 1817. (Volume CVIII, page 110.)

A paper by him "On Quadruple and Binary Compounds, particularly Sulphurets," was also published in the "Philosophical Magazine," 1807. (Volume XXIX, page 275.)

[2] These papers were collected and edited by William J. Rhees, and are contained in Volume XXI of the "Smithsonian Miscellaneous Collections," under the title of "The Scientific Writings of James Smithson" (1879).

combating (with what was then originality) the theories of the time, which referred the bones there found to "The Deluge."

"The most notable feature of Smithson's writings, from the standpoint of the modern analytical chemist," says Professor Clarke,[1] "is the success obtained with the most primitive and unsatisfactory appliances. In Smithson's day, chemical apparatus was undeveloped, and instruments were improvised from such materials as lay readiest to hand. With such instruments, and with crude reagents, Smithson obtained analytical results of the most creditable character, and enlarged our knowledge of many mineral species. In his time the native carbonate and silicate of zinc were confounded as one species under the name 'calamine'; but his researches distinguish between the two minerals, which are now known as Smithsonite and calamine respectively.

"To theory Smithson contributed little, if anything; but from a theoretical point of view the tone of his writings is singularly modern. His work was mostly done before Dalton had announced the atomic theory, and yet Smithson saw clearly that a law of definite proportions must exist, although he did not attempt to account for it. His ability as a reasoner is best shown in his paper upon the Kirkdale bone cave, which Penn had sought to interpret by reference to the Noachian deluge. A clearer and more complete demolition of Penn's views could hardly be written to-day. Smithson was gentle with his adversary, but none the less thorough for all his moderation. He is not to be classed among the leaders of scientific thought; but his ability, and the usefulness of his contributions to knowledge, cannot be doubted."

The President of the Royal Society, in a necrology for the year 1829, associated the name of Smithson with those of

1 Communication from Professor Frank W. Clarke, Chief Chemist, United States Geological Survey.

Wollaston, Young, and Davy, saying that "he was distinguished by the intimate friendship of Mr. Cavendish, and rivaled our most expert chemists in elegant analyses"; while at the annual meeting of the Royal Society held on November 30, 1830, the President, Davies Gilbert, after referring to other members recently deceased, said:

"The only remaining individual who has taken a direct and active part in our labours, by contributing to the 'Transactions,' is Mr. James Lewis Smithson, and of this gentleman I must be allowed to speak with affection. We were at Oxford together, of the same college, and our acquaintance continued to the time of his decease.

"Mr. Smithson, then called Macie, and an undergraduate, had the reputation of excelling all other resident members of the University in the knowledge of chemistry. He was early honored by an intimate acquaintance with Mr. Cavendish; he was admitted to the Royal Society, and soon after presented a paper on the very curious concretion frequently found in the hollow of bambû canes, named *Tabasheer*. This he found to consist almost entirely of silex, existing in a manner similar to what Davy long afterwards discovered in the epidermis of reeds and grasses.

"He was the friend of Dr. Wollaston, and at the same time his rival in the manipulation and analysis of small quantities. Ἀγαθὴ δ' ἔρις ἥδε βροτοῖσι.

"For many years past Mr. Smithson has resided abroad, principally, I believe, on account of his health; but he carried with him the esteem and regard of various private friends, and of a still larger number of persons who appreciated and admired his acquirements."

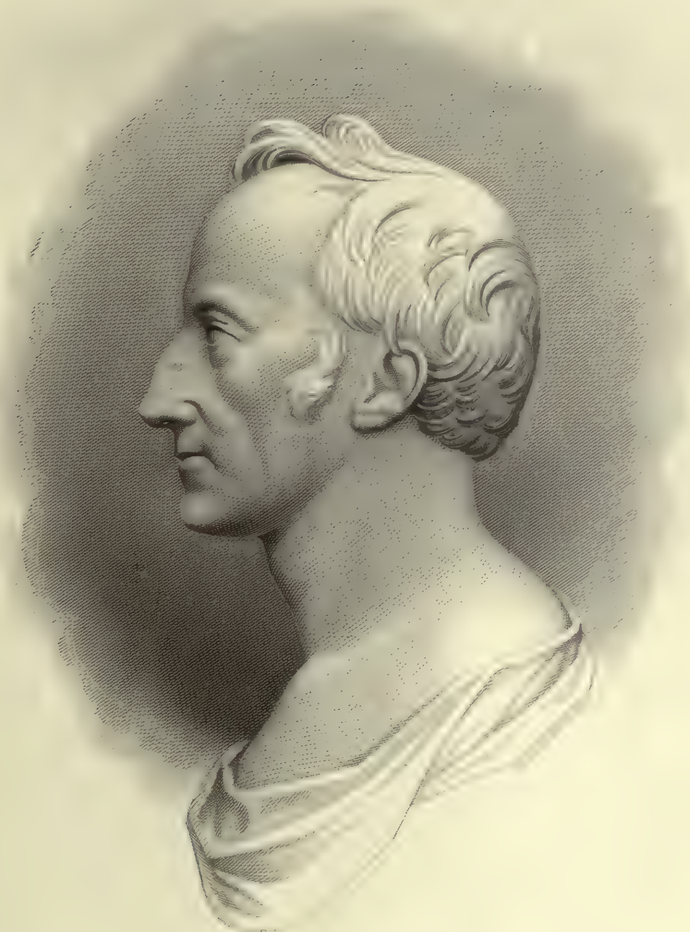
His writings exhibit clearness of perception, terseness of language, and accuracy of expression. He was an intimate friend of Cavendish, and later of Arago; he was a correspondent of Black, of Banks, of Thomson, and of most of the

names then renowned to science, and he himself contributed in those early days honorably to the enlargement of those "lurid specks in the vast field of darkness," of which he spoke, towards the coming light.

His industry was the more creditable to him in that he was at this time a man of large means, with every temptation to devote himself to amusement, and this industry will be seen to be still greater when it is remembered that these published papers are but a small portion of his writings; for 200 manuscripts were forwarded to the United States with his effects, and, besides these, thousands of detached notes and memoranda.

Unhappily, with the exception of one small volume, of all these nothing remains, the whole of the originals having been destroyed in the disastrous fire at the Institution in 1865, just one hundred years from the date of his birth. We know something of these manuscripts from the paper by Mr. Johnson, who had access to them before the formation of the Institution, and from it we learn that they are connected not only with science, but with history, the arts, language, rural pursuits, gardening, the construction of buildings, and kindred topics, "such as are likely to occupy the thoughts and to constitute the reading of a gentleman of extensive acquirements and liberal views derived from a long and intimate acquaintance with the world," while his cabinet, which was also destroyed by the fire, is described as consisting of a choice collection of minerals, comprising probably eight or ten thousand specimens, in exceedingly perfect condition, including examples of most of the meteorites which had fallen in Europe during several centuries, and forming what was at the time very much the richest and rarest collection in the United States.

If, then, we ask whether Smithson had such a competent



scientific knowledge as would enable him to use with deliberate choice the language of his will, we may answer with confidence that his was the knowledge of a professional student, and not of the amateur, that he was one who could well discriminate between what was best for the increase and what was best for the diffusion of knowledge, and that the capacity for terse expression already referred to shows itself eminently in the concision and clearness with which he expresses this distinction, in that most brief and most important of clauses of his will presently to be cited.

We have a likeness of him taken in the form of a bust, executed probably in the years when he was most active in these scientific labors. The precise date of the bust, a reproduction of which (on steel by Charles Burt, made in 1879) is here given, is unknown.

Of Smithson's subsequent life we know but little. His later years appear to have been tried by bad health and painful infirmities. During these years he seems to have resided chiefly in Paris, where he lived at Number 121 Rue Montmartre, and where he was in the habit of entertaining his friends. One gathers from his letters, from the uniform consideration with which he speaks of others, from kind traits which he showed, and from the general tenor of what is not here particularly cited, the impression of an innately gentle nature, but also of a man who is gradually renouncing, not without bitterness, the youthful hope of fame, and, as health and hope diminish together, is finally living for the day rather than for any future.

To this period belongs an interesting citation from Arago's eulogy on Ampère:

"Some years since in Paris I made the acquaintance of a distinguished foreigner, of great wealth, but in wretched

health, whose life, save a few hours given to repose, was regularly divided between the most interesting scientific researches and gaming. It was a source of great regret to me that this learned experimentalist should devote the half of so valuable a life to a course so little in harmony with an intellect whose wonderful powers called forth the admiration of the world around him. Unfortunately there occurred fluctuations of loss and gain, momentarily balancing each other, which led him to conclude that the advantages enjoyed by the bank were neither so assured nor considerable as to preclude his winning largely through a run of luck. The analytical formulas of probabilities offering a radical means, the only one perhaps of dissipating this illusion, I proposed, the number of the games and the stakes being given, to determine in advance, in my study, the amount, not merely of the loss of a day, nor that of a week, but of each quarter. The calculation was found so regularly to agree with the corresponding diminution of the bank-notes in the foreigner's pocketbook that a doubt could no longer be entertained."

I owe to Doctor B. A. Gould the interesting statement that Arago was not merely an acquaintance, but an intimate friend of Smithson, and that Arago personally told him that "the distinguished foreigner" in question was Smithson himself, and added that Smithson resolved, not to absolutely discontinue play (in which he found the only stimulus which could make him forget his physical suffering), but to do so with a care that the expenditure for this purpose was a definite one, and within his means.

We see him next entering the confines of old age, approaching the task (with such enfeebled health, a solemn one) of making his last will, and looking back upon a life which his circumstances have made lonely, which has been uncheered by domestic affection, and which, though filled with honorable activities, has not brought the fame to which he once aspired

with the hope that it would bring some compensation for the accident of birth.

The most important act of his life was the execution of this will, a copy of which follows:

THE WILL OF JAMES SMITHSON.

"I JAMES SMITHSON Son to Hugh, first Duke of Northumberland, & Elizabeth, Heiress of the Hungerfords of Studley, & Niece to Charles the proud Duke of Somerset, now residing in Bentinck Street, Cavendish Square, do this twenty-third day of October, one thousand eight hundred and twenty-six, make this my last Will and Testament:

"I bequeath the whole of my property of every nature & kind soever to my bankers, Messrs. Drummonds of Charing Cross, in trust, to be disposed of in the following manner, and I desire of my said Executors to put my property under the management of the Court of Chancery.

"To John Fitall, formerly my Servant, but now employed in the London Docks, and residing at No. 27, Jubilee Place, North Mile end, old town, in consideration of his attachment & fidelity to me, & the long & great care he has taken of my effects, & my having done but very little for him, I give and bequeath the Annuity or annual sum of One hundred pounds sterling for his life, to be paid to him quarterly, free of legacy duty & all other deductions, the first payment to be made to him at the expiration of three months after my death. I have at divers times lent sums of money to Henry Honore Sailly, formerly my Servant, but now keeping the Hungerford Hotel, in the rue Caumartin at Paris, & for which sums of money I have undated bills or bonds signed by him. Now, I will & direct that if he desires it, these sums of money be let remain in his hands at an Interest of five per cent. for five years after the date of the present Will.

"To Henry James Hungerford, my Nephew, heretofore called Henry James Dickinson, son to my late brother, Lieutenant-Colonel Henry Louis Dickinson, now residing

with Mr. Auboin, at Bourg la Reine, near Paris, I give and bequeath for his life the whole of the income arising from my property of every nature & kind whatever, after the payment of the above Annuity, & after the death of John Fitall, that Annuity likewise, the payments to be made to him at the time of the interest or dividends becomes due on the Stocks or other property from which the income arises.

"Should the said Henry James Hungerford have a child or children, legitimate or illegitimate, I leave to such child or children, his or their heirs, executors, & assigns, after the death of his, or her, or their Father, the whole of my property of every kind absolutely & forever, to be divided between them, if there is more than one, in the manner their father shall judge proper, or, in case of his omitting to decide this, as the Lord Chancellor shall judge proper.

"Should my said Nephew, Henry James Hungerford, marry, I empower him to make a jointure.

"In the case of the death of my said Nephew without leaving a child or children, or the death of the child or children he may have had under the age of twenty-one years or intestate, I then bequeath the whole of my property, subject to the Annuity of One hundred pounds to John Fitall, & for the security & payment of which I mean Stock to remain in this Country, to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase & diffusion of knowledge among men.

"I think it proper here to state, that all the money which will be standing in the French five per cents. at my death in the names of the father of my above mentioned Nephew, Henry James Hungerford, & all that in my names, is the property of my said Nephew, being what he inherited from his father, or what I have laid up for him from the savings upon his income.

JAMES SMITHSON. [L. S.]"

We see that he begins by recalling the parentage which had denied him the name of his father and the position in the

world he believed should have been his, and, in the void places of father, brother, or family, he seems to look for some object of affection, and to find only an old servant (whom he remembers with thoughtful liberality) and a nephew, to whom he bequeaths his property. He has provided for the continuance of the property to any possible heir to this nephew, and there seems to remain nothing more.

But there must have remained, in the retrospect of such a life as his, a sense of failure of that purpose with which he entered it, when he hoped, with youthful ambition, to create a greater name than that which birth had denied him, and when he wrote, "My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten," and there must have come up on such an occasion the question whether this was, indeed, the end of hope and the time only for renunciation.

We see that he has not utterly renounced this hope even now; but it is so faint that he writes between a clause which concerns a legacy to a servant and one which concerns an investment in the funds, and, as it were, almost casually, the words which have perpetuated his name.

Probably no man ever made a more remunerative investment in the direction in which he would like best to see a return than was brought out by these words of Smithson, for we now all know that his bequest, when accepted by the United States Government, formed the initial step in the creation of an institution whose position has been altogether exceptional, for it is likely to remain without successor, as without precedent, in perpetuating, as it does, the fame of a private individual, whose wishes have been adopted and carried into effect by a great nation, which has consented to take the position of a guardian to a ward in the care of his property, and which has subsequently made his

private fortune the nucleus to which have been added appropriations for objects of national importance, yet appropriations which are still administered in association with his name.

The will was proved in the Prerogative Court of Canterbury, the value of the effects being sworn to be under £120,000. The property disposed of by it is believed to have been received chiefly from Colonel Henry Louis Dickinson, a son of his mother by a former marriage, though he is known to have received a legacy of £3,000 from Dorothy Percy, his half-sister on his father's side; but, unless through this, it is proper to state that there is no indication that any portion whatever of the Smithson bequest was derived from the Northumberland family.

The motives which actuated Smithson in mentioning the United States as his residuary legatee, rather than any other government or institution, must remain in doubt, for he is not known to have had any correspondent in America, nor are there in any of his papers any reference to it or its distinguished men. In selecting the nation itself as the depository of his trust, he yet certainly testified his confidence in its institutions and his faith in their perpetuity, while it has not escaped attention that he uses language in the determining clause of his will remarkably similar to that already employed by Washington, who in his farewell address, says: "Promote, as an object of primary importance, institutions for the general diffusion of knowledge."

Smithson died June 27, 1829, at Genoa, Italy. He is buried in the little English cemetery on the heights of San Benigno, in a tomb which originally bore no reference to him as the founder of this Institution; but the Institution has recently placed a tablet there remedying this omission, has surrounded the tomb with evidence of continued care, and has

placed in still further remembrance a similar tablet in the English church of the city.

Smithson's wishes have been carried out by those immediately administering them with a constant scrupulous thought of the intent of the founder, while in doing this the best results have flowed from a rigid construction of his own words, so briefly expressed, and from a division of the activities of the Institution into two great distinct but parallel paths, the "increase" and "diffusion" of knowledge.

What has been done in these two paths the reader may partly gather from this volume — in the former, from the various articles by contemporary men of science, describing its activities in research and original contributions to the increase of human knowledge; in the latter, in numerous ways,—among others, from the description of the work of one of its bureaux, that of the International Exchanges, where it may be more immediately seen how universal is the scope of the action of the Institution, which, in accordance with its motto, PER ORBEM, is not limited to the country of its adoption, but belongs to the world, there being outside of the United States, at the time I write, more than 12,000 correspondents, scattered through every portion of the globe; indeed, there is hardly a language or a people where the results of Smithson's benefaction are not known and associated with his name.

If we were permitted to think of him as conscious of what has been, is being, and is still to be done, in pursuance of his wish, we might believe that he would feel that his hope, at a time when life must have seemed so hopeless, was finding full fruition; for events are justifying what may have seemed at the time but a rhetorical expression, in the language of a former President of the United States, who has said, "Renowned as is the name of Percy in the historical annals of England, . . . let the trust of James Smithson to the

United States of America be faithfully executed, . . . let the result accomplish his object, the increase and diffusion of knowledge among men, and a wreath more unfading shall entwine itself, in the lapse of future ages, around the name of Smithson than the united hands of history and poetry have braided around the name of Percy through the long ages past."

The principal sources of information for this chapter have been as follows:

1. *Gentleman's Magazine* for March, 1830, page 275.

2. The documentary evidence which, though meager, may be found in the report of Richard Rush to the Department of State, in 1838.

3. The manuscripts and diary of Smithson, which are described as comprising about two hundred titles, besides numberless notes of an encyclopædical character, "such as are likely to occupy the thoughts of a gentleman of extensive acquirements and liberal views." These manuscripts were destroyed by the fire of 1865, but not until extended extracts had been made from them by Walter R. Johnson, a member of the National Institute of Washington, in whose possession the papers and books of Smithson remained until the formation of the Institution. The paper by Johnson will be found in Volume XXI of the "Smithsonian Miscellaneous Collections," and these lost papers are the original sources of some statements made here which can no longer be verified by comparison with the originals.

4. These sources are not only contained in, but are largely supplemented by, the excellent memoir on "James Smithson and his Bequest," by Mr. William J. Rhees, forming part of Volume XXI of the "Smithsonian Miscellaneous Collections," without which the biography of Smithson can hardly be written, and from which the writer has here frequently quoted textually, without other acknowledgment than this general and explicit one.

5. Another source of information is the researches made by the writer with the aid of Doctor Cyrus Adler, Librarian of the Smithsonian Institution, in England, in 1894.

THE FOUNDING OF THE INSTITUTION, 1835–1846

By George Brown Goode

WHEN Smithson died in Genoa in 1829 his estate became the property of his brother's son, Henry James Hungerford, then about twenty-three years of age, who was privileged to enjoy its income during his own lifetime, and to whose heirs it was to pass at his death. Hungerford, then known as the Baron Eunice de la Batut, died in Pisa, June 5, 1835, unmarried and without heirs.

There was now no one to contest the claim of the United States to the estate except his mother, Madame de la Batut, who declared herself to be satisfied by the granting of a small annuity payable during her own lifetime.

The fact of the Smithson bequest first became known in this country in September, 1835, when there was received at the State Department a letter from Aaron Vail, chargé d'affaires of the United States in London, transmitting a copy of the will, together with certain information obtained from Smithson's solicitors in London.[1]

[1] For the letter of these gentlemen,—Messrs. Clarke, Fynmore, and Fladgate,—and the full text of all documents referred to in this chapter, see "The Smithsonian Institu-

The proposed gift of Smithson was first publicly announced by President Jackson in a message to Congress, dated December 17, 1835.

The President's message was referred in the Senate to the Committee on the Judiciary, which promptly reported in favor of accepting the legacy. Its recommendations were strongly antagonized by Senators Calhoun and Preston, of South Carolina, who, from their customary standpoint of opposition to centralization, maintained that Congress had no power to accept the gift, and that it would be beneath the dignity of the Nation to receive benefits from a foreigner. Senator Jefferson Davis, of Mississippi, and Senator Leigh, of Virginia, took strong ground on the other side, and their counsel finally prevailed after the report had lain upon the table for several months.

In the House of Representatives the announcement was received with more generous appreciation, and the message was referred to a select committee, of which John Quincy Adams was made chairman. The venerable statesman, now, ten years after his retirement from the presidency, a Representative in Congress from Massachusetts, at once took the measure under his protection. His mind seized with almost prophetic grasp upon the advances which the gift of Smithson made possible, and the arguments so eloquently presented in his report of January 19, 1836, no doubt did much to determine Congress upon the decision that the gift should be accepted:

"Of all the foundations of establishments for pious or charitable uses which ever signalized the spirit of the age or the comprehensive beneficence of the founder, none can be named

tion: Documents relative to its Origin and History," edited by W. J. Rhees, Washington, 1879, 8vo, pages i–xiv, 1–1013, a most careful and exhaustive compilation from the archives of the Institution and of the government, provided with an excellent analytical index. It also contains an abstract from the diary of John Quincy Adams.

more deserving of the approbation of mankind than this. Should it be faithfully carried into effect, with an earnestness and sagacity of application and a steady perseverance of pursuit proportioned to the means furnished by the will of the founder and to the greatness and simplicity of his design as by himself declared, 'the increase and diffusion of knowledge among men,' it is no extravagance of anticipation to declare that his name will hereafter be enrolled among the eminent benefactors of mankind.

"The attainment of knowledge is the high and exclusive attribute of man, among the numberless myriads of animated beings inhabitants of the terrestrial globe. On him alone is bestowed, by the bounty of the Creator of the universe, the power and the capacity of acquiring knowledge. Knowledge is the attribute of his nature which at once enables him to improve his condition upon earth, and to prepare him for the enjoyment of a happier existence hereafter. It is by this attribute that man discovers his own nature as the link between earth and heaven; as the partaker of an immortal spirit; as created for a higher and more durable end than the countless tribes of beings which people the earth, the ocean, and the air, alternately instinct with life, and melting into vapor or mouldering into dust.

"To furnish the means of acquiring knowledge is, therefore, the greatest benefit that can be conferred upon mankind. It prolongs life itself and enlarges the sphere of existence. The earth was given to man for cultivation, for the improvement of his own condition. Whoever increases his knowledge multiplies the uses to which he is enabled to turn the gift of his Creator to his own benefit, and partakes in some degree of that goodness which is the highest attribute of Omnipotence itself.

"If, then, the Smithsonian Institution, under the smile of an approving Providence and by the faithful and permanent application of the means furnished by its founder to the purpose for which he has bestowed them, should prove effective to their promotion, if they should contribute essentially to the *increase and diffusion of knowledge among men*, to what

higher or nobler object could this generous and splendid donation have been devoted?

"In the commission of every trust there is an implied tribute of the soul to the integrity and intelligence of the trustee; and there is also an implied call for the faithful exercise of those properties to the fulfilment of the purpose of the trust. The tribute and the call acquire additional force and energy when the trust is committed for performance after the decease of him by whom it is granted, when he no longer exists to witness or to constrain the effective fulfilment of his design. The magnitude of the trust and the extent of confidence bestowed in the committal of it do but enlarge and aggravate the pressure of the obligation which it carries with it. The weight of duty imposed is proportioned to the honor conferred by confidence without reserve. Your committee are fully persuaded, therefore, that, with a grateful sense of the honor conferred by the testator upon the political institutions of this Union, the Congress of the United States, in accepting the bequest will feel in all its power and plenitude the obligation of responding to the confidence reposed by him with all the fidelity, disinterestedness, and perseverance of exertion which may carry into effective execution the noble purpose of an endowment for the increase and diffusion of knowledge among men."

After much debate a bill was passed to authorize and enable the President to assert and prosecute the claim of the United States to the legacy bequeathed by James Smithson, and pledging the faith of the United States to the application of the bequest to the purpose of founding an institute in Washington under the name of the Smithsonian Institution —an establishment for the increase and diffusion of knowledge among men.

On the first of July, 1836, this bill became a law through the approval of the President, who at once appointed an agent to prosecute the claim. The man selected was Richard

Rush, of Pennsylvania, a lawyer of high standing, who had been Attorney-General of the United States, Secretary of the Treasury, and a candidate for the office of Vice-President. He had also been Minister to France and to England, and his official residence of eight years at the Court of Saint James fitted him admirably for the mission which he now undertook. He proceeded at once to London, entered a friendly suit in the Courts of Chancery in the name of the President of the United States, and, notwithstanding there were eight hundred cases ahead of this, he obtained a favorable decision in less than two years, an event without example in the annals of chancery, for the English lawyers themselves admitted that a chancery suit was a thing which might begin with a man's life, and its termination be his epitaph.

The success of Mr. Rush was due in a large degree to the extreme friendliness and consideration manifested by the British law officers from the Attorney-General down, without which it would have been scarcely possible for him to have accomplished in so short a period what in the ordinary course of events would at that time have required twenty or thirty years. His skill in the conduct of the case also counted for much, the American Minister testifying that no litigant ever displayed a more ardent zeal, or a more sagacious, devoted, and unremitting diligence, in the prosecution of a suit.

A still more potent influence, however, must have been his own enthusiasm for the work in which he was engaged, an enthusiasm which he succeeded in imparting to all with whom he came in contact. "A suit of higher interest and dignity," he wrote, "has rarely, perhaps, been before the tribunals of a nation. If the trust created by the testator's will be successfully carried into effect by the enlightened legislation of Congress, benefits may flow to the United States and to the human family not easy to be estimated, because oper-

ating silently and gradually throughout time, yet operating not the less effectually. Not to speak of the inappreciable value of letters to individual and social man, the monuments which they raise to a nation's glory often last when others perish, and seem especially appropriate to the glory of a republic whose foundations are laid in the presumed intelligence of its citizens, and can only be strengthened and perpetuated as that improves."[1]

On May 9, 1838, a decree of the Court of Chancery was solemnly pronounced, adjudging the Smithson bequest to the United States, and the estate was immediately transferred to Mr. Rush, who took passage for America in the packet ship *Mediator*, which sailed from London July 17, and reached New York August 29, 1838.

The various securities were converted into gold sovereigns for convenience of transportation, and these were packed at the Bank of England in one hundred and five bags, each containing 1000 sovereigns, except one which contained 960 sovereigns and certain change which Mr. Rush minutely records as amounting to "eight shillings and sevenpence wrapped in paper," a minuteness somewhat entertaining, since in another place he records with equal minuteness that he delivered eight shillings and sixpence at the Mint.

The money was deposited with the Bank of America until September 1, when Mr. Rush, accompanied by two agents of the Bank, took stage for Philadelphia, and on the same day delivered his charge to the Director and Treasurer of the United States Mint. The contents of the bags, £104,960, 8s., 6d., was found to be the equivalent of $508,318.46, which was the amount for which Mr. Rush obtained a receipt.

[1] Letter to the Honorable John Forsyth, Secretary of State, dated London, May 12, 1838. For all the correspondence and other documents relating to Rush's mission to England, see Rhees, "The Smithsonian Institution: Documents relative to its Origin and History"; Washington, 1879, pages 3–122.

The sum was subsequently increased by the repayment of certain amounts expended in the prosecution of the claim, freights, insurances, etc., so that the original trust amounted in all to £106,374, 9s., 7d., or $515,169. The sum of £5015 sterling which was held back during the lifetime of Madame de la Batut, after her death, in 1862, was added to the fund, and in February, 1867, the Board of Regents was informed that the amount of the Smithsonian Fund in the Treasury had been increased to $550,000.[1]

As soon as the trust fund reached the United States, in 1838, it was invested by the Secretary of the Treasury in stocks of States, chiefly in 500 bonds of the State of Arkansas for $1000 each, bearing six per cent. interest.[2] The State of Arkansas having failed to pay its interest in 1846, Congress made good the deficiency from the public funds, as in duty bound by the pledge given in the bill approved July 1, 1836, and has ever since paid interest at six per cent. on the sum of $538,000, which was the total amount at that time invested in Arkansas securities.

Shortly after the convening of Congress in 1838, President Van Buren, in a message dated December 6, informed both Houses that the legacy had been received and invested, and invited their attention to the obligation devolving upon the United States to fulfil the object of the bequest. His message was accompanied by several letters from "persons versed in science and in matters relating to education," who had been invited by the President to communicate their views to aid his judgment in presenting the subject to Congress.

Eight years passed by before a definite plan of organiza-

[1] Rhees, *loc. cit.*, page 133.

[2] This was done in accordance with the Act, approved July 7, 1838, directing the Secretary of the Treasury, with the approbation of the President, to invest all the money arising from the bequest of Smithson in stocks of States. This Act was repealed September 11, 1841, through the agency of Mr. Adams.

tion was determined upon, although at each session of Congress the President urged prompt action. Though at the time the delay seemed irksome, no one can doubt that it was in the end advantageous. At first the importance of the occasion was not fully appreciated, and the projects presented were limited in scope. Suggestions were offered by a large number of persons, and almost every suggestion was embodied in one or more of the bills which were brought up for discussion during this formative period. The broad and liberal plan at last adopted was the result of a process of selection by which unworthy features were thrown out, and only those retained which commended themselves to the wisdom of an intelligent majority.

When the subject was first considered in the Senate, it seems to have been generally believed that the intention of the testator was to establish a university, and this was the preference of those to whom, in July, 1838, the Secretary of State, by direction of the President, addressed letters asking advice in regard to the proper application of the bequest.[1] Seven communications elicited by this invitation were under consideration in 1838, and of these, five favored a school corresponding to what would now be called a postgraduate university. Doctor Wayland suggested an institution which should occupy "the space between the close of a collegiate education and a professional school"; Doctor Cooper, "an institution of the character of a university," open only to graduates of other colleges; and President Chapin, of Columbian University, "an institution for liberal and professional purposes and for the promotion of original investigations — to carry through a range of studies much above those of the ordinary collegiate course." Professor Dunglison, of the Uni-

[1] The persons addressed were the Honorable John Quincy Adams, ex-President; Thomas Cooper, M. D., of the University of South Carolina; the Honorable Richard Rush; Doctor Francis Wayland, President of Brown University; and others.

versity of Virginia, advocated "a central school of natural science," where natural philosophy, chemistry, geology, mineralogy, philosophy, and all other sciences could effectually be taught, to be supplemented in time by a botanical garden, an observatory, a zoölogical institute, and other similar agencies. Mr. Rush objected to a school of any kind, and proposed a project which corresponds more nearly than any other of those early days to that which was finally adopted. In a shadowy yet far-seeing way he outlined a system of scientific correspondence, of lectureships, of general coöperation with the scientific work of the government, a liberal system of publication, and collections—geological, zoölogical, botanical, ethnological, and technological.

Ex-President Adams urged the establishment of a great astronomical observatory, "equal to any in the world," and he continued to urge this from year to year, and to introduce bills in which this feature was included, until, indeed, provision for astronomical work was made by the establishment of an observatory in connection with the navy. The bill considered by Congress in 1839[1] provided for the establishment of an observatory fully equipped, with provision for the publication of its observations and the annual preparation and publication of a nautical almanac. This, which had evidently been prepared by a minority of the joint committee, was reinforced by two sets of resolutions proposed by Mr. Adams in the House.

One, reported from the committee, January 26, provided:

"That the first appropriations from the interest or income of the Smithsonian fund ought to be for the erection and establishment, at the city of Washington, of an astronomical observatory, provided with the best and most approved instruments and books, for the continual observation, calcu-

[1] House Bill No. 1161; Senate Bill No. 293.

lation, and recording of the remarkable phenomena of the heavens, for the periodical publication of the observations thus made, and of a nautical almanac, for the use of the mariners of the United States and of all other navigating nations."

The second, reported February 6, recited the opinion:

"That the education of the children of these United States is a duty of solemn and indispensable obligation incumbent upon their parents and guardians, not for the increase and diffusion of knowledge among men, but to qualify them for the enjoyment of their rights and the performance of their duties throughout life, [and therefore] that no part of the Smithsonian fund ought to be applied to the education of the children or youth of the United States, nor to any school, college, university, or institute of education."

These resolutions were evidently intended to antagonize the views still held by many Senators, and urged in the speech of Senator Robbins, of Rhode Island, in January, 1839, who declared "that this institution should make one of a number of colleges, to constitute a university, to be established here, and to be endowed in a manner worthy of this great nation and their immense resources."

On February 18, Senator Robbins offered a counterpoise to Mr. Adams's anti-university resolution in the following:

"1. *Resolved*, That it is the duty of the United States, they having accepted the trust under the will of Mr. Smithson, of London, to execute that trust *bona fide*, according to the true intent and meaning of the testator.

"2. *Resolved*, That the trust being to found an institution in the city of Washington for the increase and diffusion of knowledge among men, the kind of institution which will have the effect intended and described, in the most eminent degree, will be the kind of institution which ought in good faith to be adopted, as being most in accordance with the true intent and meaning of the testator.

"3. *Resolved*, That all experience having shown scientific and literary institutions to be by far the most effectual means to the end of increasing and diffusing knowledge among men, the Smithsonian Institution should be a scientific and literary institution, formed upon a model the best calculated to make those means the most effectual to that end.

"4. *Resolved*, That to apply said trust fund to the erection and support of an observatory would not be to fulfil *bona fide* the intention of the testator, nor would it comport with the dignity of the United States to owe such an establishment to foreign eleemosynary means."

The Twenty-fifth Congress adjourned without action, and Senator Robbins having retired from public life, the university idea was not afterward so prominent. At this time additional petitions were received. One was from Professor Walter R. Johnson, of Philadelphia, pleading for an institution for researches in physical science, especially in connection with the useful arts, which would have corresponded in a general way with the scientific branches of the present Department of Agriculture, though he proposed work in many other directions.[1]

Another was from Charles L. Fleischmann, a graduate of the Royal School of Agriculture in Bavaria, proposing the establishment of an institution for the promotion of agriculture, with experimental farms of 1360 acres, manufactories, mills, and workshops, a considerable staff of teachers and instructors, and one hundred students at the commencement.[2]

The Agricultural Society of Kentucky was pleading for an agricultural school, the Superintendent of the Coast Survey for a school of astronomy, and Mr. James P. Espy for a meteorological bureau with a system of wide-spread simultaneous observations.

[1] Presented to the House of Representatives May 21, 1838. See Rhees, *op. cit.*, pages 171–186.

[2] Reported to the House of Representatives January 9, 1839. See Rhees, *op. cit.*, pages 186–198.

The interest of the public became much greater; earnest discussions were printed in the newspapers and reviews; letters urging speedy action were written to Congress by persons in all parts of the country, and the Corporation of the City of Washington also presented a vigorous memorial to the national legislature.

Soon after the Twenty-sixth Congress convened, President Adams again introduced his bill for the establishment of a national observatory, accompanied by a learned and exhaustive report upon the importance of astronomical work, supplemented by a statement from the Astronomer Royal of Great Britain concerning the observatories at Greenwich and elsewhere. His ideas did not meet with favor. In his journal for 1843 he records with much disgust that the Secretary of the Treasury said to him in conversation that the prejudice against his plan of an astronomical observatory was insurmountable because he had once called observatories "light-houses in the skies."

Strenuous as was his desire for an observatory, it was feeble in comparison with his apprehension lest the fund should be "squandered upon cormorants, or wasted in electioneering bribery," and his desire to save it "from misapplication, dilapidation, and waste." His dread became almost morbid, and he looked with suspicion upon every one who was interested in the disposition of the bequest, even those whose names are now remembered in connection with his own as the most public-spirited promoters of the interests of the Institution in its days of embryonic existence. He would coöperate with no one, and his influence must be characterized as conservative rather than formative, his most important service being his opposition to the bill for investing the fund in State stocks, which, in 1841, he succeeded in having repealed.

While these things were happening at the Capitol, new

agencies were coming into existence which were destined to exert a very positive and decisive influence upon the character of the new organization. Chief among these was the National Institution, a society organized May 15, 1840, by the adoption of a constitution and a declaration of objects, which were, "To promote science and the useful arts, and to establish a national museum of natural history," etc. Its constitution, as printed on the cover of the second bulletin of the society, was decidedly prophetic of the future plan of the Smithsonian Institution. The society was established in a broad and liberal way. Its membership was strong, including at the beginning about ninety representative men of Washington, among them members of Congress, scientific men, clergymen, and prominent citizens, and an equal number of corresponding members, including all the leading men of the country. Among its officers were ex-President Adams, the Secretary of War, the Secretary of the Navy, the Chief of Engineers of the Army, and other prominent officials. Its meetings were largely attended, its promoters were enthusiastic, gifts of books and specimens began to come in, and its prospects were in every way flattering.

From the beginning, the Smithson legacy and its proper disposition was the subject most frequently discussed by the founders of the National Institution. For years, indeed, it was the opinion of many influential men that this society ought to be made the custodian of the Smithson fund. How strongly this was urged is indicated in the letter addressed to the Secretaries of War and of the Navy in 1842, in which the managers stated that the object of the National Institution is "*to increase and to diffuse knowledge among men*," making prominent the words of Smithson, instead of the official designation of the objects of their own society.

The influence of the society was strongly and continuously

exerted upon Congress during the six years from its organization until the Smithsonian Act was eventually passed, and resulted in the final engrafting of a national museum upon the Smithsonian project, and also in the addition of various features of organization which have since become such characteristic elements in the plan of the Smithsonian Institution.

The controlling mind in this movement was undoubtedly that of the Honorable Joel R. Poinsett, of South Carolina, who was Secretary of the Navy in 1840, and at whose residence the society was organized. Mr. Poinsett was, under the first plan of organization, senior director, and occupied the chair at every meeting until, in 1841, under an amended constitution, he was elected its first president. Notwithstanding the fact that officers were annually elected, he told Mr. Adams soon after this election that he should for two years to come preside over the National Institution, a clear indication of the controlling influence which he consciously exerted. He was in fact reëlected to the presidency at each annual meeting until 1845, when, having declined the candidacy, he was elected an honorary member, and Senator Woodbury, of New Hampshire, became president in his place. From this period the decline in the prosperity of the society was marked.

It is certain that as early as 1838, when the bequest was first received, Mr. Poinsett was thinking seriously about its disposal. This is made clear by an entry in the diary of John Quincy Adams, under date of December 8, in which the ex-President describes his interview and was evidently impressed with the idea that Mr. Poinsett did not give him his entire confidence.

In April, 1839, they discussed the matter again, and in 1841 Mr. Adams wrote again in his diary: "April 1. Mr. Poinsett called upon me and now fully disclosed his project, which is to place the investment and disposal of the

Smithsonian funds under the management of the American Institution for the Promotion of Literature and Science [evidently meaning the National Institution]. He concurs entirely in my views of confining the appropriations to the annual interest, leaving the principal unimpaired, and of making the first appropriations for the establishment of an astronomical observatory. . . . He said he had at present no other occupation on hand, and would be willing to devote two years entirely to organizing this establishment and getting it into full operation." "I know not," added the aged statesman, "that it could be accomplished more effectively, and think I must acquiesce in this arrangement and endeavor to carry it through. The chief obstacle, however, will now be to extricate the funds from the fangs of the State of Arkansas. Mr. Poinsett thought that they paid the interest upon the bonds punctually; but the law requires that the interest should, when paid, be immediately reinvested in State stocks, and I struggled in vain at the last session of Congress to obtain a repeal of that law. Mr. Poinsett said he was now going in a very few days to South Carolina, but should soon return here . . . to preside over the National Institution for the Promotion of Science; and, as he expressed a wish that the Smithsonian fund might be connected with that Institution and placed under its management, I requested him to take the bill reported to the House with my report of 5th March, 1840, and prepare any amendment to it which would carry out his views, and send it to me before the approaching session of Congress; which he said would do."[1]

[1] Extracts from the memoirs of John Quincy Adams, Rhees, "The Smithsonian Institution: Documents relative to its Origin and History," pages 769, 774, 779, 780.

Mr. Poinsett was not only the first to publicly suggest the union of the Smithsonian with the National Institution, but was constant in his advocacy of the project. (See remarks, March 8, 1841, *Proceedings of the National Institution*, page 69, and letter, February 7, 1842, *Proceedings of the National Institution*, page 157.) Dr. Peter S. Duponceau, president of the American Philosophical Society, in a letter to the institution in November, 1840, re-

Poinsett, when elected to the presidency of the National Institution, was a man of sixty-two. He had lived an eventful life, full of opportunities for observing the institutions of Europe, Asia, and South America. His culture was broad and sympathetic, and he was better fitted, perhaps, than any of the public men of his time to appreciate the necessity of organizing our institutions in accordance with a liberal and comprehensive plan. In his interviews with those who advocated an observatory as the first result of the Smithson bequest, he showed a full appreciation of the value of such an institution, but seems to have kept before his own mind a much more comprehensive ideal. In his address upon the "Objects and Aims of the National Institution for the Promotion of Science," delivered at the first anniversary meeting, January 4, 1841, he referred pointedly to the Smithson bequest, saying that it offered a favorable occasion for carrying into effect all the important objects connected with the National Institution, such as that which he was then addressing, enabling the government to afford all necessary protection to the promotion of science and the useful arts,[1] without the exercise of any doubtful power.

Soon after this, in February, Senators Linn, of Missouri,

marked: "Congress cannot find a better opportunity to execute the will of that beneficent testator than by laying hold of your institution and making it its own." (*Proceedings*, page 12.) The Honorable Virgil Maxey, Chargé d'Affaires at Brussels, wrote in December, 1840, that in his opinion no better use could be made of the bequest than to place it under the direction of a society organized for the proper carrying into effect views identical with those contemplated by the philanthropical and philosophical testator. (*Proceedings*, page 46.)

See in this connection letters from Richard Rush, on the Smithsonian Bequest (*Proceedings of the National Institution*, 1842, pages 201–204); from Peter S. Duponceau, on the Smithsonian Bequest (*op. cit.*, pages 204–208); from Honorable Virgil Maxey, Chargé d'Affaires of the United States at Brussels (*op. cit.*, pages 46–47); Opening Address by John Tyler, President of the United States, patron of the National Institute (*op. cit.*, pages 437–438); letter from the Honorable Levi Woodbury, United States Senate (*op. cit.*, pages 451–453); Smithsonian Bequest, by the Honorable Richard Rush (*op. cit.*, pages 455–460); address of Honorable Mr. Preston, of the United States Senate (*op. cit.*, page 236); letter of John Pickering, of Boston, September 1, 1841 (*op. cit.*, pages 107–110).

[1] These were the avowed objects of the National Institution, as can be seen by reference to its constitution.

and Preston, of South Carolina, both members of the National Institution, proposed new bills for the organization of the Smithsonian Institution, at the same time reporting a bill to incorporate the National Institution for the Promotion of Science. By these bills, the entire management of the Smithsonian foundation was to be intrusted to the National Institution. Its officers, a superintendent, and six professors, were to be nominated by that society, which was also to prescribe their duties. Provision was made for joint occupancy by the two institutions of buildings to be erected at the cost of the Smithson bequest, and finally it was required that all collections of works of art and of natural history owned by the United States, not otherwise assigned (or "all works of art, and all books relating thereto, and all collections and curiosities belonging to the United States in the possession of any of the Executive Departments and not necessarily connected with the duties thereof") shall be deposited in said buildings (or "shall be transferred to said institution, to be there preserved and arranged").

Poinsett's enthusiasm was contagious, and his arguments, manifestly based upon careful observations and judicious reasoning and inspired by hopeful patriotism, brought him many sympathizers. Among these the Honorable Levi Woodbury, who had been a member of the same Cabinet with Mr. Poinsett, and was subsequently in the Senate, Senator Preston, of South Carolina, one of the directors of the Institute, Senator Walker, of Mississippi, and Senator Linn, of Missouri, corresponding members, appear to have been especially friendly to the plans of Mr. Poinsett, and on various occasions from 1841 to 1846 promoted the interests of the National Institution on the floor of the Senate.

In June, 1842, Mr. Poinsett was again in Washington, and

presided at a meeting for the purpose of connecting the organization of the National Institution with that of the Smithsonian Institution.

"Mr. Preston," wrote John Quincy Adams, "has introduced into the Senate a bill for combining these two institutions, and now stated to the meeting his views on the subject, embracing an appropriation of $20,000 and the occupation by law of a large portion of the Patent Office building, for the preservation and arrangement of the objects of curiosity collected by the exploring expedition under Lieutenant Wilkes, now daily expected home; and he called on me to say how far my purposes may be concurrent with these suggestions.

"I said I had the warmest disposition to favor them, and thought there was but one difficulty in the way, which might perhaps be surmounted. I had believed that the whole burden and the whole honor of the Smithsonian Institution should be exclusively confined to itself, and not entangled or commingled with any national establishment requiring appropriations of public money. I exposed the principles upon which all my movements relating to the Smithsonian bequest have been founded, as well as the bills which at four successive Congresses I have reported, first, for obtaining the money, and then for disposing of the fund.

"At the motion of Mr. Walker, of Mississippi, the President, Mr. Poinsett, was authorized to appoint a committee of five members of the Institute, to confer with Mr. Preston and me upon the means of connecting the Smithsonian Institution with the National Institute."

Nothing resulted from these deliberations.

On June 13, at a stated meeting of the National Institution, Senator Preston was present, and delivered, as the records relate, "an eloquent speech, in which he descanted at length on the history and labor of the Institution, what it had done, and what it proposed to do, its capacity to be eminently useful to the country and Congress, the advan-

tage of uniting the Smithsonian Institution with it, etc., and appealed to Congress and to the liberal citizens of the United States to come forward in aid of a glorious cause and in the accomplishment of the great national objects which the Institution has in view,"[1] etc.

Senator Preston's bill for the union of the two establishments came to naught.[2]

During this session, however, the act to incorporate the National Institute, as it was henceforth to be called, passed in a much modified form, and was approved July 27, 1842,[3] and the society now seems to have felt much more secure in its project of retaining control of the National Museum, and of gaining eventually the management of the Smithson fund, or, at least, of obtaining an appropriation from Congress.

Senator Woodbury,[4] of New Hampshire, in commenting upon the form of the charter, remarked that "care was taken originally to make the Institute different from all other chartered bodies, even in this District, so as to elevate it above every motive of personal gain, dedicating its labors exclusively to objects of a public character and vesting all the property possessed for this purpose in the government itself; and thus, by rendering it *national* in substance as well as name, to obviate any constitutional objection which might arise against measures in its behalf."

The change of the name from "Institution" to "Institute" was made in deference to a suggestion by Doctor Peter S.

1 *Proceedings of the National Institution*, page 236. A copy was requested for publication (*loc. cit.*, page 241), but I cannot learn that it was ever put in type.

2 It was laid upon the table July 18, 1842, and never again came up.

3 See "Charter of Incorporation, Constitution and By-Laws" in *Proceedings of the National Institution*, pages 388–392. See also "Bill to Incorporate the National Institution," etc., reported by Senator Preston (Senate Bill No. 258), February 17, 1841, in Rhees, "Documents," etc., pages 239–341. See also "Memorial of the Officers of the National Institution for the Promotion of Science, January 21, 1842" (House Documents No. 59, Twenty-Seventh Congress, Second Session, II.), submitting draft of a bill of incorporation.

4 For a thorough understanding of the matter see the remarks of Senator Woodbury in full, which were printed in the *Proceedings of the National Institution*, pages 336, 337.

Duponceau in a letter written in April, 1842, in which he said:

"I have seen with great pleasure the bill brought into the Senate by the Honorable Mr. Preston. It fully coincides with the views that I have expressed. The object, in my opinion, is to preserve the superiority of the National Institution over the Smithsonian, and of the government over both.

"I would beg leave to suggest whether it would not be advisable to make some small alteration in the name of the National Institution so that it should not bear exactly the same name with the Smithsonian, but one expressive of some degree of superiority. I would recommend, for instance, that of Institute, which appears to me more dignified than that of Institution, which is equally applicable to a school or college as to a great national establishment for the promotion of science. My idea would be to call the national establishment the 'National Institute for the Promotion of Science,' and the subordinate one the 'Smithsonian Institution,' without more."

No appropriation came, however, and the charter and changed name failed to add to the prosperity of the society. At a meeting on June 20,[1] 1842, a resolution was passed appointing a committee to solicit private contributions of money and property. On August 8, 1842, a report was made by this committee proposing to institute an annual scientific convention at Washington, during the session of Congress, and under the auspices of the Institute, and also recommended an extensive system of exchange of specimens for the benefit of the museum.

At the meeting of September 12, 1842, Mr. Poinsett, the president, proposed a series of resolutions[2] intended to put the recommendation of the report into effect.

[1] Evidently not June 13, though so stated in one portion of the minutes. See *Proceedings of the National Institution*, pages 236, 241, 335.

[2] See *Proceedings of the National Institution*, page 336.

All of these resolutions and reports were issued in the form of circulars,[1] but the appeals "to the liberality and public spirit of our countrymen" were without avail. Consequently a special meeting of the board of management was held December 23, 1843, at the office of the Secretary of State. That the society was regarded at that time as one of national importance is shown by the presence at the meeting of Mr. Abel P. Upshur, Secretary of State, who took an active part in the proceedings; the Honorable John Quincy Adams, who presided; Senator Levi Woodbury, late Secretary of the Treasury, who agreed to represent the meeting in Congress; the Honorable Joseph R. Ingersoll, who acted as secretary, and who wrote out in his preamble to the minutes of the meeting a forcible statement of the needs of the society; the Honorable Charles J. Ingersoll, Senator Robert J. Walker, besides the Honorable Peter Force, Colonel John J. Abert, Colonel Joseph G. Totten, Lieutenant Matthew F. Maury, and the officers of the society.

The issue of this meeting was the decision "to memorialize Congress on the subject of the condition and wants of the Institute." The memorial was presented in due course, and in June, 1844, Senator Choate, of Massachusetts, presented a report upon the character and uses of the Institute, recommending that its property should be vested in the United States and an appropriation made for its benefit.

In the mean time, on the occasion of the first annual meeting of the National Institute under its new name and in its capacity as a corporation, in April, 1844, the meeting of the friends of science, including, besides all the members and patrons of the National Institute, the members of the American Philosophical Society and of the Association of American Geologists and Naturalists (the predecessor of the American

[1] October 15, 1842, and February 24, 1843.

Association for the Advancement of Science), had been held in Washington. The occasion was a brilliantly successful one. The President of the United States presided at the first meeting and some prominent public man at each of the others.

The National Institute received its full share of encomium. President Tyler, in presiding at the first meeting, lauded it highly, held out the hope that the government would "continue to it a fostering care," and expressed in a general way the hope that it should be identified with the future National Museum and the future Smithsonian Institution. "Where can the government find," said he, "a safer depository for the fruits of its expeditions, fitted out to explore distant and unknown regions, than the National Institute? What can it better do for the 'increase and diffusion of knowledge among men' than by patronizing and sustaining this magnificent undertaking?"

Senator Walker, of Mississippi, one of the directors of the Institute, delivered an address on the present condition and history of American science, ending with an appeal to scientific men to come forward and unite with the people in sustaining and advancing the National Institute.

Senator Woodbury, of New Hampshire, in a letter to the secretary, expressed himself strongly in favor of making the society the agent of the government in the matter of caring for collections, patents, and copyrights, and also in the execution of the Smithson trust.

John Quincy Adams closed his address in these words:

"I avail myself of this occasion to express my regret that, having taken an humble part in the establishment of this institution from its first foundation, under the auspices of Mr. Poinsett, I have been able to contribute so little to its promotion and advantage, and to add my heartfelt satisfaction

at the prosperity which, by the untiring exertion and fervid zeal of its executive officers, it has attained. I believe it eminently deserving of the fostering care and liberal patronage of the Congress of the United States, and could anticipate no happier close to my public life than to contribute, by my voice and by my vote, to record the sanction of the nation's munificence to sustain the National Institute devoted to the cause of science."

The Honorable Richard Rush, in a paper on "The Smithsonian Bequest," submitted to this meeting, urged that the Smithsonian fund should be "engrafted upon the National Institute," and submitted an elaborate argument in favor of his proposal.

It was a gala week for the Institute. The meeting was in every respect a success, and there was reason to believe that Congress would share in the general enthusiasm, take the society under its patronage, and even give it the control of the Smithson fund.

In the circular of invitation, dated March 5, 1843, the objects of the meeting as a means of strengthening the position of the society had been boldly stated, and the committee did not hesitate to say that "should the meeting prove as successful as the hopes of the managers in relation to it are ardent, they will expect hereafter to welcome all who may visit the association in apartments peculiar to itself, stored with the objects of its honest pride and worthy of its distinguished visitors." Such a paper, signed by such influential names as those of John C. Spencer, Secretary of the Treasury; Robert J. Walker, William C. Rives, Rufus Choate, of the Senate; Joseph R. Ingersoll and William C. Preston, of the House of Representatives; Alexander D. Bache, Superintendent of the Coast Survey; and Abbott Lawrence, of Boston, was surely a powerful campaign document. None the less weighty was

the "Memorial of the Friends of Science who attended the April meeting of the National Institute," signed by nearly forty representative scientific men and college presidents from all parts of the United States, speaking in terms of high commendation of the National Institute, and particularly of the extent and value of its museum material, and expressing the hope "that the enlightened and intelligent members of Congress will distinguish the present session by the appropriation of funds to an object so truly national and so truly republican."

The hopes of the promoters of the Institute were doomed to disappointment. Congress adjourned without making any provision for its needs.

In July a new scheme was proposed for collecting money from private sources by the efforts of trustworthy agents, and in December a committee was appointed to again memorialize Congress.[1] The movement had, however, received its death-blow. The failure of the tremendous effort of April, 1844, disheartened all its friends. At the next annual meeting Mr. Poinsett declined reëlection to the presidency. The society's publications were discontinued, and even the annual address of Senator Woodbury, solicited for publication by the society, seems to have remained in manuscript unprinted. No more meetings were held, and the list of 350 resident and 1250 corresponding members began to grow shorter. An effort was made to revive it in 1847, and a meager report was made once afterward by the corresponding secretary. In 1855 it was brought into existence for a time as a local scientific society,[2] and issued a new series of proceedings. Its glory departed, however, with the first annual meeting, in 1844, and the attention of Congress was directed exclusively to the organization of the Smithsonian Institution.

1 *Proceedings of the National Institute*, page 375.

2 Professor Henry was for a time an officer, and endeavored to have its name changed to "Metropolitan Institute."

The influence of the National Institute upon the history of science in the United States, and particularly in educating public opinion and the judgment of Congress to an application of the proper means of disposing of the Smithsonian legacy, cannot well be overestimated. If the Smithsonian Institution had been organized before the National Institute had exerted its influences, it would have been a school, an observatory, or an agricultural experiment-station.

In 1846, however, the country was prepared to expect it to be a general agency for the advancement of scientific interests of all kinds—as catholic, as unselfish, as universal as the National Institute had been prepared to be.

The National Institute, after nearly five years of activity, suddenly ceased to be a center of public interest. The struggle over the Smithsonian bequest, however, was still going on. During the Twenty-seventh Congress (1841–1843) the Senate did nothing. The House of Representatives appointed a select committee on the subject, and Mr. Adams as chairman reported a new bill, providing still more thoroughly for the erection of an observatory and the publication of a nautical almanac to be called the Smithsonian Almanac.

The Twenty-eighth Congress (1843–1845) brought its deliberations in regard to the Smithsonian bequest more nearly to an issue. The astronomical observatory bill[1] was again presented by Mr. Adams, but not acted upon. In the Senate, in the first session, a bill for the Smithsonian Institution was reported June 6, 1844, from the Joint Committee on the Library, by Senator Tappan, of Ohio, who in the second session, December 12, introduced another bill, somewhat similar, but presenting the character of the books to be bought. This bill, before being finally voted upon, was brought into a form somewhat resembling that which was

[1] House of Representatives 418, Twenty-eighth Congress.

finally adopted. It provided, however, for the appointment of various professors and lecturers, for a school of agriculture and mechanical arts, as well as for experimental gardens, a library of science and economics, and a museum.

The museum clause of this bill was much the same as that finally agreed to, and contained a provision that the natural history objects, and geological and mineralogical specimens belonging to the United States, "in whosesoever custody the same may be," should be transferred to the custody of the board of managers of the Smithsonian Institution. This was evidently worded with the purpose of withdrawing from the possession of the National Institute the various collections, including those which had belonged to Smithson, which had fallen into its hands between 1840 and 1845. Indeed, the National Institute seems to have already become the object of some distrust and prejudice. A proposition that two of the seven "managers," not *ex officio* members of the board, should be selected from the membership of the National Institute, caused a vigorous debate in the Senate, in the course of which at least two Senators objected strongly to placing the administration of the Smithsonian Institution, even to so slight a degree as this, in the hands of a private corporation.

The bill finally passed the Senate, January 23, 1845, but was not acted upon by the House.

In connection with Mr. Tappan's bill, in January, 1845, Senator Choate, of Massachusetts, first appeared in advocacy of the establishment of "a noble public library,— one which, for variety, extent, and wealth, should be equal to any in the world,"— and delivered an eloquent oration upon the influence of books. The amendment at that time proposed by him, together with other amendments urged by Mr. George P. Marsh, in connection with the Owen-Hough bill, brought

forward in the following session, had a great influence upon the final adjustment of the plan of administration.[1]

To the Twenty-ninth Congress (1845–1847) belongs the honor of finally formulating the act of incorporation by which the Smithsonian Institution was established. This was at last accomplished under the leadership of Robert Dale Owen, of Indiana, who reported the bill nearly in its final form, though somewhat modified in a substitute offered by Mr. William J. Hough, and still more by the refusal of the House to agree to Mr. Owen's favorite feature of a normal school. John Quincy Adams was a member of the select committee to which it was referred, together with Mr. Owen, chairman; Mr. Timothy Jenkins, Mr. George P. Marsh, Mr. Alexander D. Sims, Mr. Jefferson Davis, and Mr. David Wilmot.

Mr. Adams was now for the first time willing to cease his advocacy of a Smithsonian Astronomical Observatory, the Naval Observatory having been organized on a plan "at least equal in everything but the experience of its observers to the Royal Observatory at Greenwich."

In the Hough bill, which was a modification of that of Owen, there was an attempt of another kind to weld together the Smithsonian Institution and the "National Cabinet of Curiosities," by giving to the Board of Regents the authority to erect a building by the side of the Patent Office, so as to form a wing of that structure, and to connect it with the hall then containing the National Cabinet, so as to constitute that hall in whole or in part the depository of the cabinet of the Institution. This was discretionary, however, with the Regents, who fortunately did not look upon the plan with favor.

Reference has been made to the marked similarity between the plans of organization of the National and Smithsonian Institutions. The former, like the Smithsonian, had a su-

[1] See report of Honorable James Meacham, 1854, pages 10–12.

perior board of officers, composed of the President of the United States and the members of his Cabinet. It had also a board of directors, which included in its membership delegates from the Senate and House of Representatives, corresponding in function to the Smithsonian Board of Regents. In other respects, still more markedly than in the constitution of its governing board, the Smithsonian seems to have been organized with the plan of the National Institute in view.

The objects, as defined in the Congressional act of establishment,[1] correspond very closely to those announced in the early publications of the National Institute, which at its foundation divided its members into eight classes, as follows: (1) Astronomy, Geography, and Natural Philosophy; (2) Natural History; (3) Geology and Mineralogy; (4) Chemistry; (5) The application of same to useful arts; (6) Agriculture; (7) American History and Antiquities; (8) Fine Arts.

The term "manager" to designate a member of the governing board, and which was derived from the organization of the National Institute, was employed in every bill except in the substitute proposed only a few hours before final action, when it was replaced by the term "regent," which was doubtless suggested by Mr. William J. Hough, the mover of the substitute, a representative of the State of New York, and familiar with the organization of the University of the State of New York, which was under the control of a board of regents.

Ten years after the announcement of the bequest, and eight years after the beginning of the contest as to its disposition, the bill to incorporate the Smithsonian Institution received the approval of Congress and the President. The charter in its final form did not represent the views of any one party, except in some degree that which favored the

[1] Sections 5 and 6.

library and incidentally the museum. The bill as finally presented contained several special provisions not harmonious with the spirit of Smithson's bequest as at present understood. These were, for the most part, eliminated in the final discussion, and the Act finally passed by Congress, and approved by the President, August 10, 1846, while broad enough to permit almost any work for intellectual advancement, was fortunately expressed in such general terms as to allow a large degree of liberty to the governing board.

The Board of Regents was appointed without delay, and their meeting was held on September 7 in a room in the General Post-Office Building set apart for their use by direction of the President of the United States. Though many wise men participated in the councils in which the manner of executing the trust of Smithson was decided, there are certain names which are especially significant as those of the statesmen and patriots who made the interests of the infant institution their own special care, and who, by their wisdom and earnest advocacy, shaped its destiny. It seems proper that in this memorial volume an attempt should be made to show what each of these contributed to the final result.

John Quincy Adams was perhaps the most influential in securing the acceptance of the bequest and in creating a high ideal for its administration. He antagonized the idea of using it to found a university, and defeated Owen's project for a normal school, which was only eliminated from the bill a few minutes before final action. He opposed all projects for making its work directly practical. His influence was limited by his pertinacious advocacy of the idea that the founding of an observatory was the only proper distribution of the first income of the fund. His position in this matter has been misunderstood. He wished that the income for seven successive years should go to found an observatory. "During

this period," he said, "there will be ample time for considering the best means of appropriating the same income afterward to promote establishments for increasing and diffusing knowledge among men. A botanical garden," he continued, "a cabinet of natural history, a museum of mineralogy, conchology or geology, a general accumulating library — all institutions of which there are numerous examples among the civilized Christian nations, and of most of which our own country is not entirely destitute — all are undoubtedly included within the comprehensive grasp of Mr. Smithson's design — all may receive, in turn, and with progressive utility and power, liberal contributions from the continually growing income of the trust. Nor did the committee believe that the moral or political sciences, the philosophy of language, the natural history of speech, the graces of polite literature, the mechanic or the liberal arts, were to be excluded from the benefits prepared for posterity by the perpetuation of this fund." He did not desire that a permanent organization should be formed, believing, though wrongly, as the event has proved, that such an organization could not be kept efficient and pure under the control of a government like ours; and his suspicions in regard to the motives of those who seemed interested in the project undoubtedly lessened his power of controlling it.

His most important service was to establish the principle that only the interest of the fund should be used, and that the principal should be permanently invested in the Treasury of the United States. This, after all, was his chief ambition — "to secure, as from a rattlesnake's fang, the fund and its income, forever, from being wasted and dilapidated in bounties to feed the hunger or fatten the leaden idleness of mountebank projectors and shallow and worthless pretenders to science."[1]

[1] Rhees, "The Smithsonian Institution: Documents," etc., page 849.

John Davis, of Massachusetts, was the one in the Senate who, in 1836, stoutly maintained, against much opposition, that the government had the right to accept the bequest and to apply it for the purpose indicated by Smithson, saying that "he deemed the establishment of institutions for the diffusion of knowledge a vital principle of a republican government."

Joel R. Poinsett, of South Carolina, aided by his associates of the National Institute, exercised an influence greater perhaps than any other in shaping the final disposition of the fund. The Smithsonian Institution became in time almost the equivalent of the National Institute, as in 1841 he hoped it would be,—an institution which, having at its command an observatory, a museum containing collections of all the productions of nature, a botanic and zoölogical garden, and the necessary apparatus for illustrating every branch of physical science, would attract together men of learning and students from every part of our country, would open new avenues of intelligence throughout the whole of its vast extent, and would contribute largely to disseminate among the people the truths of nature and the light of science. To Poinsett are due: (1) the idea of an important building, which should be a permanent feature at the capital; (2) the plan for a national museum of science and art, with a staff of curators; (3) the determining of the location of the Institution upon the Mall; (4) the main features of the plan of organization, with the President and his Cabinet as trustees, and a subordinate board of trustees selected by Congress in part from among its own members; (5) the inauguration of a system of international exchanges of books, under the inspiration of Alexander Vattemare, which, though not provided for in the organizing bill, was actually in operation as early as 1841, with indirect aid from the government.

Rufus Choate, of Massachusetts, and George P. Marsh, of Vermont, were instrumental in giving prominence to the library project, upon which so much of the fund was expended during the first few years—a feature which, though at the time almost perilous, undoubtedly had great effect not only upon the development of the National Library, but of the relationship of the Smithsonian Institution to other institutions of learning at home and abroad. To Mr. Choate and to Benjamin Tappan was due in large degree the defeat of the aspirations of the National Institute toward the control of the Smithsonian fund, and to Senator Asher Robbins, of Rhode Island, the defeat of Mr. Adams's plan for an observatory, to which at the time he opposed, with considerable prospect of success, a counter-project for a great postgraduate university.

Richard Rush, of Pennsylvania, not only rendered material service in securing the legacy, but was the first to propose a staff of scholarly investigators resident in the national capital, who, by their researches, publications, and lectures, should aid in keeping the United States in touch with the scientific progress of the rest of the world; and a press for publishing the communications of learned societies and of individuals eminent in science and letters in every part of the world. Most significant, however, was his conception of a permanent national organization, under the wing of the government and indirectly under its control, which should be a center of intellectual activity, and not only maintain its own staff of learned men, but coöperate with and stimulate the scientific and educational work of the government — a plan, as has already been indicated, quite in contrast with that in the mind of Mr. Adams.

Robert Dale Owen, of Indiana, was the first to bring into harmonious and generally acceptable form the various plans

which had been under consideration for ten years before. He prepared the final act of incorporation, which was drawn up by him in 1845, and which was, except in the elimination of his plan for a national normal school, but slightly changed in the substitute which was finally passed. As a member of the first Board of Regents, he was instrumental in selecting and carrying out the plan for the Smithsonian building, and, as chairman of the Organization Committee, drew up, with the assistance of Alexander Dallas Bache, the "Report on Plan of Organization," in which the organizing Act was analyzed and expounded, and many of the possibilities of the future for the first time clearly set forth. From this Committee was also reported at an early meeting the following resolution, from the adoption of which, and its legitimate outcome, there have been more significant results than through any other act of this or any succeeding board:

"*Resolved*, That it is essential, for the advancement of the proper interests of the trust, that the Secretary of the Smithsonian Institution be a man possessing weight of character, and a high grade of talent; and that it is further desirable that he possess eminent scientific and general requirements; that he be a man capable of advancing science and promoting letters by original research and effort, well qualified to act as a respected channel of communication between the Institution and scientific and literary individuals and societies in this and foreign countries; and, in a word, a man worthy to represent, before the world of science and of letters, the institution over which this board presides."

The successful organization of the Institution has been the result of long-continued effort on the part of men of unusual ability, energy, and personal influence. No board of trustees, no succession of officers serving out their terms in rotation, could have developed from a chaos of conflicting opinions

a strongly individualized establishment like the Smithsonian Institution. The names of Henry and Baird are so thoroughly identified with the history of the Institution during its first four decades that their biographies would together form an almost complete history of its operations. A thirty-two years' term of service was rendered by one, thirty-seven by the other. Perhaps no other organization has had the benefit of so uninterrupted an administration of forty years, beginning with its birth and continuing in an unbroken line of consistent policy a career of growing usefulness and enterprise.

The first meeting of the Board of Regents took place September 6, 1846, and before the end of the year the policy of the Regents was practically determined upon, for, after deciding upon the plan of the building now occupied, they elected to the secretaryship Professor Joseph Henry, and thus approved his plan for the organization of the Institution which had previously been submitted to them.

Henry was succeeded in the office of Secretary by Professor Spencer Fullerton Baird, then the leading authority on the mammals, birds, fishes, and reptiles of America, the founder of the United States Fish Commission, and of "public fish culture," elected in 1878; and he in turn by Samuel Pierpont Langley, preëminent as physicist and astronomer, the inventor of the bolometer, the discoverer of the greater portion of the infra-red spectrum, and the highest authority upon the physics of the atmosphere, elected in 1888.

THE ESTABLISHMENT AND THE BOARD OF REGENTS

BY GEORGE BROWN GOODE

THE SMITHSONIAN INSTITUTION is a corporation or Establishment, created by the act of Congress approved August 10, 1846, "for the increase and diffusion of knowledge among men."

Its statutory members are the President of the United States, the Vice-President of the United States, the Chief Justice of the United States,[1] the Secretary of State, the Secretary of the Treasury, the Secretary of War, the Attorney-General, the Postmaster-General, the Secretary of the Navy, the Secretary of the Interior, and the Secretary of Agriculture.

The duty of the Establishment is the "supervision of the affairs of the Institution and the advice and instruction of the Board of Regents." The Establishment has, from time to

[1] The original act of incorporation also named as members of the Establishment the Commissioner of the Patent Office of the United States and the Mayor of the city of Washington. This act was amended March 20, 1871, so as to substitute the Governor of the District of Columbia as an *ex officio* Regent, in place of the Mayor of Washington, the latter office having ceased to exist. In 1874 the office of Governor of the District of Columbia was in turn abolished. In 1877 the Secretary of the Interior, and in 1894 the Secretary of Agriculture, were added as members of the Establishment.

time, selected eminent citizens of the United States to be honorary members of the Institution, and to share with them the responsibilities with which they are charged. The persons thus honored[1] have been Doctor Robert Hare, of Philadelphia; the Honorable Albert Gallatin, of New York; Professor Benjamin Silliman, of Connecticut; Washington Irving, of New York; Professor Parker Cleaveland, of Maine; Doctor Augustus B. Longstreet, of Mississippi; and the Honorable Columbus Delano, of Ohio.

The first meeting of the Establishment was held August 1, 1849, in the newly completed eastern range of the Smithsonian building, Zachary Taylor, President of the United States, occupying the chair. Eight meetings have since been held, the last on May 5, 1877, adjourning to meet at the call of the President.

The Establishment, though exercising constant supervision over the affairs of the Institution, being represented upon the Board of Regents by two of its members, one of them the Chancellor, as its presiding officer, has never deemed it necessary to take any formal action at its meetings, save to adopt, May 17, 1853, a code of by-laws,[2] and to listen from time to time to general statements by the Secretary in regard to the condition and affairs of the Institution.

The Regents of the Smithsonian Institution are charged by the act of incorporation with the duty of conducting the business of the Institution. Two members of the Establishment, the Vice-President of the United States and the Chief Justice, are, in virtue of their office, members of the Board of Regents. There are also three members of the Senate, three members of the House of Representatives, and six citizens, no two of whom may be from the same State, though two

[1] The law as amended on March 12, 1894, omits the phrase "such other persons as they may elect honorary members," and no honorary member has been elected since the year 1873.

[2] See "Smithsonian Report," 1853, page 98.

must be residents of the city of Washington. The presiding officer of the Board of Regents is the Chancellor of the Smithsonian Institution, who is elected by the Board of Regents from among their own number. This office has, however, always been held either by the Vice-President or by the Chief Justice.[1]

The executive officer of the Board of Regents is the Secretary of the Institution, who is elected by them. The duties and responsibilities of Secretary are such as in other institutions usually belong to the office of Director: the name by which this officer is designated is that which in Washington is associated with the highest grade of executive responsibility. The Secretary makes all appointments on the staff, the members of which are technically his "assistants." He is responsible for the expenditure and disbursement of all funds of the Institution, is the legal custodian of all its property, and, *ex officio*, its librarian and the keeper of its museum.

He presents to the Regents an annual report upon the operations, expenditures, and condition of the Establishment, which is transmitted by the Board to Congress for publication. By a special act of Congress in 1879 and amended in 1884, an Acting Secretary is provided for, in case of the absence or disability of the Secretary, the designation being left with the Chancellor of the Institution.

[1] Vice-President Dallas was the first Chancellor, and was succeeded by Vice-President Fillmore. When Mr. Fillmore was elevated to the Presidency of the United States, in 1850, Chief Justice Taney was elected Chancellor. In 1857 Mr. Taney resigned the place on the ground that the Vice-President, the highest in rank of the officers of the government who are *ex officio* Regents, was the proper person to preside. "Unfortunate events," he continued, "have for some time past left the government without a Vice-President elected by the people. And when that office was vacant the Regents conferred on me the office, which had always before been filled by the Vice-President. And when I accepted it I regarded the appointment as a temporary one. The reason for the appointment has now happily ceased, and I desire to give the Regents an opportunity of restoring the original plan of organization, in which I fully concurred when it was adopted." Mr. Breckinridge, Vice-President of the United States, who was present at this meeting, moved that the present Chancellor, Chief Justice Taney, be reëlected to that office. The precedent thus established of electing the Chief Justice to be Chancellor of the Institution has never since been abandoned.

The first meeting of the Regents for the purpose of organization was held on September 7, 1846, in a room in the Patent Office building, assigned for the purpose by the President of the United States.

At this meeting were present George M. Dallas, of Pennsylvania, Vice-President of the United States; Roger B. Taney, of Maryland, Chief Justice of the United States; William W. Seaton, Mayor of the city of Washington; Senator George Evans, of Maine; Senator Isaac S. Pennybacker, of Virginia; Robert Dale Owen, Representative from Indiana; William J. Hough, Representative from New York; Henry W. Hilliard, Representative from Alabama; the Honorable Rufus Choate, of Massachusetts; Doctor Gideon Hawley, of New York; and Richard Rush, of Pennsylvania, citizens at large; Doctor Alexander Dallas Bache and Colonel Joseph G. Totten representing the National Institute of Washington. Senator Sidney Breese, of Illinois, was present at subsequent meetings during the course of organization.

Since the date of organization, the Board of Regents have held 218 meetings, an average of about four to each year. The record of their proceedings up to 1876 occupies a volume of three hundred pages, and if extended up to the present year would require four hundred pages.[1] This record, it need scarcely be said, relates only to the actual transactions of the Board and its committees at its regular meetings. The reports of the Board to Congress occupy fifty volumes, including in all about thirty-eight thousand pages.

The regular annual meetings of the Board are held in January. Since January, 1890, the day has been fixed for the fourth Wednesday of the month.

The Executive Committee of the Regents provided for by

[1] "The Smithsonian Institution: Journals of the Board of Regents, Reports of Committee's Statistics," etc. Edited by William J. Rhees, Washington; published by the Smithsonian Institution, 1879. Octavo, pages v–vii, 844.

the law holds quarterly meetings for the purpose of auditing the accounts for expenditures made in accordance with the appropriations voted by the Board at its annual meeting. The Executive Committee has also customarily performed the duties of a Committee of Ways and Means, besides acting upon many matters directly referred to it by the Board. Two of its members have always been the two Regents resident in Washington, and the third some other member, not a Senator or Representative, living near enough to Washington to be readily accessible. The Executive Committee, therefore, soon became an Advisory Committee, practically always in session, which the Secretary constantly consults in regard to the interpretation of questions of policy, and the method of carrying out the instructions of the Board. The citizen residents have usually served for longer periods than others as members of the Executive Committee, and many of them have become intimately associated with the executive work of the organization.

Since the organization of the Board of Regents, fifty years ago, the names of 129 persons have appeared upon its roll. Among these are a large number of the most distinguished citizens of the United States,—men eminent in statesmanship and diplomacy, in governmental administration, in science, in literature, and in arts. Each one of these has contributed his share to the prosperity of the Institution by his counsel and good judgment.

The long list of distinguished names here given shows how carefully the Regents have been selected, so that representative men from every section of the Union might be included in that important body.

From the Middle States: William J. Hough, Gideon Hawley, Millard Fillmore, Samuel Sullivan Cox, John V. L. Pruyn, William B. Astor, William A. Wheeler, Andrew D.

White, and Levi P. Morton, from New York; William L. Dayton, Professor John Maclean, of Princeton University, and William Walter Phelps, from New Jersey; George M. Dallas, Richard Rush, Edward McPherson, Hiester Clymer, Robert Adams, Jr., and President Henry Coppée, of Lehigh University, from Pennsylvania.

From the Southern States: Chief Justice Taney, Henry Winter Davis, James A. Pearce, from Maryland; Isaac S. Pennybacker, James M. Mason, Robert E. Withers, General Joseph E. Johnston, from Virginia; William R. King, George E. Badger, from North Carolina; William C. Preston, from South Carolina; William F. Colcock, Robert M. Charlton, John M. Berrien, Hiram Warner, Lucius J. Gartrell, Benjamin H. Hill, and Alexander H. Stevens, from Georgia; General Henry W. Hillard and General Joseph Wheeler, from Alabama; Jefferson Davis, Otho R. Singleton, Randall L. Gibson, from Mississippi; President William Preston Johnson, of Tulane University, from Louisiana; Garrett Davis, John Cabell Breckinridge, John W. Stevenson, and William C. P. Breckinridge, from Kentucky; Andrew Johnson, from Tennessee; William Lyne Wilson, from West Virginia; Samuel B. Maxey, from Texas.

From the New England States: Rufus Choate, Henry Wilson, E. Rockwood Hoar, George F. Hoar, Cornelius C. Felton, Professor Louis Agassiz and Professor Asa Gray, of Harvard University, and Henry Cabot Lodge, from Massachusetts; Lafayette S. Foster, President Theodore D. Woolsey, Noah Porter, and Professor James Dwight Dana, of Yale College, from Connecticut; James W. Patterson, from New Hampshire; George P. Marsh, James Meacham, Luke P. Poland, Justin S. Morrill, and George F. Edmunds, from Vermont; George Evans, William Pitt Fessenden, Hannibal Hamlin, Nathan Clifford, from Maine.

From the Western States: Benjamin Stanton, Salmon P. Chase, Benjamin F. Wade, James A. Garfield, Chief Justice Waite, Ezra B. Taylor, John Sherman, and Benjamin Butterworth, from Ohio; Robert Dale Owen, Graham N. Fitch, Thomas A. Hendricks, William H. English, and Schuyler Colfax, from Indiana; Sidney Breese, Stephen A. Douglas, Lyman Trumbull, John F. Farnsworth, Shelby M. Cullom, David Davis, and Chief Justice Fuller, from Illinois; George W. McCrary, Stephen F. Miller, and Nathaniel C. Deering, from Iowa; Robert McClelland, Lewis Cass, David Stuart, Thomas W. Ferry, and President James B. Angell, of the University, from Michigan; Gerry W. Hazleton, from Wisconsin; John J. Ingalls, from Kansas; George Gray, from Delaware; and Aaron A. Sargent and Newton Booth, from California.

As representatives from the District of Columbia, the following Mayors of Washington served from 1846 to 1871, *ex officio*, upon the Board of Regents:

William Winston Seaton, Walter Lenox, John W. Maury, John T. Towers, William B. Magruder, Joseph G. Berret, Richard Wallach, Sayles J. Bowen, and Matthew G. Emery; followed in 1872 by Henry D. Cooke, and in 1874 by Alexander R. Shepherd, Governors of the District.

Those who have served as citizens from the city of Washington have been Professor Alexander D. Bache, Superintendent of the United States Coast Survey; General Joseph G. Totten, U. S. A.; General Robert Delafield, U. S. A.; the Reverend Peter Parker, D. D.; General William T. Sherman, U. S. A.; George Bancroft; General Montgomery C. Meigs, U. S. A.; President James C. Welling, of Columbian University; ex-Senator John B. Henderson; and Gardiner G. Hubbard.

Among the Congressional Regents, those who were long-

est in service were: Representative Samuel S. Cox, from 1861 to 1865, from 1870 to 1875, from 1882 to 1883, and again from 1888 to 1889; Senator James A. Pearce, from 1847 to 1862; Representative James A. Garfield, from 1865 to 1873, and from 1878 to 1880; Senator James M. Mason, from 1849 to 1861; and Senator Justin S. Morrill, from 1883 to the present.

The chairmanship of the Executive Committee was held by Mayor Seaton from 1846 to 1849, by General Totten in 1850 and again in 1862, by Professor Bache in 1851 and again in 1863, by Senator Pearce from 1852 to 1861, by Mayor Wallach in 1864 and 1865, by General Delafield from 1866 to 1870, by Doctor Parker from 1871 to 1883, by Professor Maclean from 1884 to 1885, by President Welling from 1886 to 1893, by President Coppée in 1894, and by ex-Senator Henderson in 1895 and 1896.

Upon the rolls of this committee also appear the names of Robert Dale Owen, General William T. Sherman, Honorable George Bancroft, General Montgomery C. Meigs, Honorable Gardiner G. Hubbard, and Honorable William L. Wilson.

Among this company of distinguished men, including many of the Americans most eminent in their day, there have been some who had opportunities to identify themselves more actively than others with the work. It would, perhaps, not be proper, or indeed possible, to make particular mention of any of these but for the fact that the Regents themselves have from time to time recorded in their Journal of Proceedings special words of commendation and appreciation of such of their associates as they considered to have rendered extraordinary services.

On the occasion of the death of Richard Rush, at the meeting of the Board on January 28, 1860, Senator Pearce, after alluding to the very important services rendered by him in

England for the recovery of the fund bequeathed by Smithson, remarked:

"The act of Congress of 1846 having established the Smithsonian Institution, he was appointed one of its first Regents, and was constantly continued by Congress a member of their Board. His zeal for the increase and diffusion of knowledge among men, and his sound judgment, contributed to the adoption of the system of operations which, so far, has borne the happiest fruits; and his interest in and care for its successful management furnished one of the enjoyments of a tranquil old age, 'attended by reverence and troops of friends.'"

At a meeting held January 31, 1863, Professor Bache, in his eulogy of Senator James Alfred Pearce, of Maryland, said:

"Again has death invaded our circle, and taken from our councils and our active sympathies one of the most admirably gifted intellects which has at any time been called upon to shape the destiny or direct the labors of the Smithsonian Institution. A member of the Executive Committee from nearly the second year of the organization under the act of Congress of 1846, attentive to every detail, whether scientific, administrative, or financial, Mr. Pearce was always prompt at the call of every duty. His entire and cordial acquiescence in the form of organization adopted for the Institution, his liberal and zealous coöperation with the Board of Regents, his earnest support of, and unfaltering confidence in, the discretion and integrity of its Secretary, were as conspicuous as they were productive of the most lasting and important benefits. And though it is true that the general form and policy of the Institution were determined under the authority of Congress, by the first Board of Regents, yet it is quite as certain that strenuous action was afterwards needed to maintain it in its adopted course, and secure it from projected innovations which, though strenuously advocated at the time, few now regard with aught but disfavor. To this end no one

lent more effectual aid than our lamented colleague. Although from taste and the conditions of his active life he might more properly be styled a literary man, yet were his scientific attainments by no means inconsiderable, and a liberal and cultivated mind, which admitted of no narrow views, enabled him to embrace, in all its comprehensive simplicity, the idea of the generous foreigner who, in founding this Institution, consecrated his fortune to 'the increase and diffusion of knowledge among men.'

. . . . . .

"The objects which in Congress occupied most of his attention, and which it gave him most pleasure to defend and sustain, were those connected with literature and science, and in these he showed the same qualities which, as chairman of our Executive Committee, he has here so often exhibited. With the great interests of State and the high objects of national politics he was abundantly qualified to grapple; in fact, he shrunk from no occasion in which to exert himself when enlarged views and skilful powers of debate could be rendered serviceable to his country or the world. But if duty called upon him from time to time for such efforts, still it was to objects promotive of art and science and high civilization, to means for man's moral and intellectual improvement, and the enlargement of his knowledge and power over nature, that he turned with ever new and unwearied interest. To him probably more than to any other Senator the library of Congress was indebted for the augmented fund which it has now for some years enjoyed, and for the care taken in the selection of the materials which render its shelves so useful. The exploring expedition was more than once indebted to his earnest and persistent efforts for the continuance of the means of publication of its results; the Coast Survey for expositions of its importance to the country and the world; the Smithsonian for warding off assaults and reconciling enthusiastic but misguided opposition; the naval and military expeditions, boundary surveys, and explorations, for close, searching investigations which led to important improvements and to cor-

dial support. The great work of the extension of the Capitol found in him a wise advocate and judicious friend. Not afraid of what was new, yet he aimed at nothing for the sake of novelty. In connection with the decoration of our public buildings, our sculptors and painters found in him a most enlightened appreciator of their works, and one always ready to promote the great cause of their art by legitimate means."

At the meeting of January 28, 1867, a resolution was passed referring to the long and gratuitous services of William W. Seaton. In this connection, Professor Henry spoke of his association with the Institution in the following terms:

"At the first meeting of the Board of Regents he was elected Treasurer, and subsequently one of the Building Committee. The former office he continued to hold until the time of his death, and during the whole of this period, nearly twenty years, discharged its duties without other compensation than the pleasure he derived from an association with the Institution, and the laudable pride he felt in contributing to its prosperity and usefulness. It is well known that at the time of the organization of the Institution a wide diversity of opinion existed as to the practical means which would be most suitable for realizing the objects of the legacy. Mr. Seaton, on mature reflection, finally gave his cordial support to the policy which sought to impress on the Institution a truly cosmopolitan character. He strenuously advocated the plan which the Secretary, then recently elected, had been invited to submit to the Board of Regents, and which looked to the advancement of knowledge chiefly through the encouragement and publication of original researches, a system which, without neglecting other available means for the promotion and diffusion of scientific enlightenment, may be claimed, without undue pretension, to have made the Institution favorably known, and to have exerted a well-recognized influence wherever men occupy themselves with intellectual pursuits.

"The relation borne by Mr. Seaton to the city of Washington, the delight with which he watched and aided its progress, a certain native taste also for artistic embellishment, led him to take special interest in the architectural character of the Smithsonian building and the ornamentation of the public grounds around it.

"Mr. Seaton was a constant attendant at the meetings of the Board of Regents, and from his familiarity with the early history of the Institution and the state of the funds, as well as from his long experience in public office, was enabled to offer suggestions, always marked by clearness of conception and soundness of judgment. The social attentions which he was accustomed to extend to the Regents, especially those who were called from abroad to attend the annual meetings, and to gentlemen invited to lecture before the Institution, were but the expression of his characteristic hospitality; but by thus adding to the pleasure of their sojourn in Washington, he contributed largely to increase the number of its friends and supporters. The columns of the 'National Intelligencer,' under his direction, were always open to the defense of the policy adopted and the course pursued by the Institution, and he rarely failed to soften, by the courtesy of his manner and the moderation of his expressions, any irritable feeling which might arise in the discussion of conflicting opinions. It would, indeed, be difficult to say in how many and in what various ways he contributed to the popularity as well as to the true interests of the Institution. The Secretary, who was in the habit of conferring with him on all points requiring mature deliberation, may with justice acknowledge that he never failed to derive important assistance from the wisdom of his counsels."

At a meeting on February 22, 1867, similar resolutions were passed in honor of the memory of Professor Alexander Dallas Bache, who had served as a Regent and one of the Executive Committee from its first organization to the time of his death. In a eulogy prepared by Professor Henry, at the

request of the Regents, the following statement in regard to his services, which were by the Secretary deemed more significant than those of any other of its early members, is made:

"In 1846 he had been named in the act of incorporation as one of the Regents of the Smithsonian Institution, and by successive reëlection was continued by Congress in this office until his death, a period of nearly twenty years. To say that he assisted in shaping the policy of the Establishment would not be enough. It was almost exclusively through his predominating influence that the policy which has given the Institution its present celebrity was, after much opposition, finally adopted. The object of the donation, it will be remembered, had been expressed in terms so concise that its import could scarcely be at once appreciated by the general public, though to the cultivators of science, to which class Smithson himself belonged, the language employed failed not to convey clear and precise ideas. Out of this state of things it is not surprising that difference of opinion should arise respecting the proper means to be adopted to realize the intentions of the founder of the Institution. Professor Bache, with persistent firmness, tempered by his usual moderation, advocated the appropriation of the proceeds of the funds principally to the plan set forth in the first report of the Secretary, namely, of encouraging and supporting original research in the different branches of science. Unfortunately this policy could only be partially adopted, on account of the restrictions of the enactment of Congress by which provision was to be made for certain specified objects. He strenuously opposed the contemplated expenditure of a most disproportionate sum in the erection and maintenance of a costly edifice; but failing to prevent this, he introduced the resolution adopted by the Board as a compromise, whereby the mischief which he could not wholly avert might at least be lessened. This resolution provided that the time of the erection of the building should be extended over several years, while the

fund appropriated for the purpose, being in the mean time invested in a safe and productive manner, would serve in some degree to counterbalance the effect of the great and unnecessary outlay which had been resolved on. It would be difficult for the Secretary, however unwilling to intrude anything personal on this occasion, to forbear mentioning that it was entirely due to the persuasive influence of the Professor that he was induced, almost against his own better judgment, to leave the quiet pursuit of science and the congenial employment of college instruction to assume the laborious and responsible duties of the office to which, through the partiality of friendship, he had been called. Nor would it be possible for him to abstain from acknowledging with heartfelt emotion that he was from first to last supported and sustained in his difficult position by the fraternal sympathy, the prudent counsel, and the unwavering friendship of the lamented deceased.

"His demeanor in the Board was quiet and unobtrusive, and his opinions sought no support in elaborated or premeditated argument; but when a topic likely to lead to difficulty in discussion was introduced, he seldom failed, with that admirable tact for which he was always noted, to dispose of it by some suggestion so judicious and appropriate as to secure ready acquiescence and harmonious action. The loss of such a man in the councils of the Institution, when we consider the characteristics which it has been our aim to portray, must, indeed, be regarded as little less than irreparable."

At a meeting on December 19, 1873, Mr. Garfield, speaking of the death of Chief Justice Chase, said:

"As the Chancellor of this Institution, we saw in happy and harmonious action his ample knowledge of our institutions, his wide experience of finance, his reverential love for science and art, and his unshaken faith in the future of his country as the grand theater for the highest development of all that is best and greatest in human nature. No contribution to science offered to this Board escaped his attention.

Nothing that was high or worthy in human pursuits failed to elicit his appreciative and powerful support."

At a meeting, January 18, 1882, Chancellor Waite thus referred to the services of President Garfield:

"General Garfield first took his seat in Congress at the end of the year 1863. He was then but thirty-six years old.

"At the beginning of his second term he was appointed a member of this Board by the Speaker of the House of Representatives, and was present at the meeting of February 3, 1866. He continued to hold the same position until 1873, when another was appointed in his place. He appeared again, however, in 1878, and we were never afterwards deprived of his counsels until he was elected President of the United States, which made him *ex officio* the presiding officer of the Smithsonian Institution.

"From the beginning his presence here was felt. He was eminently fitted for such a trust.

"He was himself a scholar, and the 'increase and diffusion of knowledge among men' always gave him the greatest pleasure.

"At every meeting of the Board during his successive terms, when he could be present, his name appears among active and thoughtful members. He manifested his appreciation of the place he filled by always doing what it was his privilege to do, and doing it well. When on former occasions the Board has given expression to its feelings upon the death of a member his words of heartfelt sympathy have often been heard. The records show that he knew and appreciated the great and good qualities of Chief Justice Chase, and that he fully realized the debt science owed to Agassiz. But the crowning act of all was when, out of the fullness of his heart, at the memorial services in the hall of the House of Representatives, he made those who heard him feel how great the life of Professor Henry had been.

"It is not for us to say he ought to have been spared

longer. Few men seemed to possess greater power for good. He died as he lived, an honor to human nature."

At a meeting on January 21, 1885, on the occasion of the resignation of Doctor Peter Parker from the Board, resolutions were passed expressing "high appreciation of the valuable and efficient services he had rendered to the Institution, for, when required, he had worked without weariness and watched without flagging, even after he had begun to feel the burden of age."

On the occasion of the death of Chancellor Waite, in 1888, it was by the Regents resolved:

"That while an obvious sense of propriety must dictate that we should leave to others in that great forum which was the chosen arena of his life's career the sad privilege of depicting, with minute and detailed analysis, the remarkable combination of strong and lovely traits which met in the person of the late Chief Justice and gave to the symmetrical character of our beloved friend its blended sweetness and light, we cannot omit, even in this hour of our special sorrow, to bear our cheerful testimony to the pleasing amenity with which he presided over the deliberations of this council chamber as the Chancellor of the Smithsonian Institution; and sharing, as we all do, in a profound admiration for the intelligence he brought to our discussions while ever moderating them by the guidance of his clear thought and mild wisdom, we can but render our reverent homage to the engaging personal qualities which endeared him to us as a man, while at the same time gratefully confessing our obligations to him for the provident care and deep interest which he always brought to the discharge of his official duties in this place, where, through all the years of his honorable and useful service at the head of this Board, the Secretary of the Institution, in common with ourselves, has leaned on him as the wise and true counsellor who could be trusted as well for the

rectitude of his moral intuitions as for the clear perceptions of his calm and judicious intellect."

At a meeting on January 18, 1889, on the occasion of the death of Professor Asa Gray, after fifteen years of service, a committee of Regents reported as follows:

"Upon the Smithsonian Institution his loss falls with particular weight, since his active interest in its welfare is almost continuous with its existence, for he was one of the Committee of the American Academy of Arts and Sciences, the report of which upon the 'plan proposed for the organization of the Smithsonian Institution,' rendered in 1847, has exercised so active an influence upon the subsequent history of this Establishment.

"Appointed a Regent in January, 1874, to succeed Professor Louis Agassiz, his efficient and active interest in the welfare of this Institution has been one of its most valuable possessions, and it is with deeper feeling than formal resolutions of regret usually convey that we now endeavor to express some part of our sense of irreparable loss."

On the death of the Honorable Samuel S. Cox, in 1890, after a period of service as Regent which, though occasionally interrupted, continued in the neighborhood of thirty years, at a meeting of the Board on January 8, 1890, a committee reported that—

"While he was not a regular attendant at all the meetings of the Board, he was ever ready to advance the interests of the Institution and of science, either as a Regent or as a member of Congress; and although such men as Hamlin, Fessenden, Colfax, Chase, Garfield, Sherman, Gray, and Waite, in a list comprising Presidents, Vice-Presidents, Chief Justices, and Senators of the United States, were his associates, there were none whose service was longer or more gratefully to be remembered, nor perhaps any to whom the Institution owes more than to Mr. Cox."

In 1892, General Montgomery C. Meigs, U. S. A., who had been for seventeen years a member of the Executive Committee, died, and Doctor Coppée, in a memorial record presented at the annual meeting, said:

"His valuable services to the Institution began, indeed, before he was officially connected with it as Regent, and continued until his death, rendering most important service in 1876 by designing the new building for the National Museum, a marvel of economic design. Directly upon his entrance into the Board, December 26, 1885, he became an active member of its Executive Committee. He was always present, extremely painstaking, and eminently judicious in his counsel and judgment on important points of business and policy. He had just been nominated as Regent for another term of six years when he was taken away from us by sudden illness. Few Regents have been of such importance to the Institution."

Appropriate action was taken at the meeting held on January 23, 1895, by the adoption of suitable resolutions in honor of the memory of President Welling. On that occasion Doctor Coppée said:

"Doctor Welling was one of the most valuable citizens of Washington, to whom was confided many trusts, among them the presidency of the Columbian University and the chairmanship of the Executive Committee of this Institution; and he did well everything that was confided to him. He was a man pure in thought, honest in purpose and action, and intelligent in judgment. He held a ready pen, and how polished his public utterances were, all here would remember who had heard him when he presented papers and other matters before this Board."

Also the following tribute to his interest in the Institution was made by Secretary Langley:

"I will only add, speaking of him still chiefly in his relationship to this Institution, that in 1884 he was chosen one of its Regents, to succeed the Reverend Doctor Peter Parker. For ten years he gave conscientious attention to its interests, and upheld in every way those conservative and dignified traditions of which I have already spoken of him as almost the living embodiment; and while he did this primarily because of their harmony with his own personal tendencies and convictions as to their value, he did so also because of his affection and reverence for the first Secretary, Joseph Henry, whose pupil he had been in his youth, and with whom in middle life he maintained the relation of friend and confidant. After Henry's death, Doctor Welling consented to add to his already burdensome duties those of the chairman of the Executive Committee, which he performed till his own death, so that he may be said to have been a link between the past and the present in the history of this Institution, though happily not the only one, since it has preserved others in his contemporaries."

The death of Doctor Henry Coppée was announced by the Chancellor at the meeting held on March 21, 1895. The following resolutions were presented by Senator Henderson:

"That the Board of Regents feels sincere sorrow in the loss of one whose distinguished career as a soldier, a man of letters, and whose services in the promotion of education command their highest respect and admiration. That in the death of Doctor Coppée the Smithsonian Institution and the Board of Regents have suffered the loss of a tried and valued friend, a wise and prudent counsellor, whose genial courtesy, well-stored, disciplined mind, and sincere devotion to the interests of the Institution will be ever remembered."

General Wheeler said that "forty years ago he was a pupil of Doctor Coppée, and from that time to his death, owing to various connections and associations, by correspondence and

by visit, he had known him, and therefore felt well fitted to speak of the high qualities referred to in the resolutions."

It should be remembered, however, that the passing of resolutions and the delivery of eulogies have only been customary when a member of the Board has continued actively associated with the Institution until the time of his death. It should not be forgotten that several of the Regents who were most active in the defense of the Institution and in the advancement of its interests were so remote in time and place from the organization at the time of their death that no reference to their services stand recorded upon the Journal.

In this connection, then, it seems but just to refer to the activities of Robert Dale Owen, in securing the passage of the act organizing the Institution, and as chairman of its Building Committee; the intense interest shown by Rufus Choate, in the promotion of the library and bibliographical work of the Institution in its days of organization, thus supplementing the valuable services rendered at a still earlier day in the Senate in preventing the diversion of the fund to unworthy ends; the courageous attitude of Henry W. Hilliard, of Alabama, in defending the Institution and its Regents from an attack in the House of Representatives on the part of Andrew Johnson, of Tennessee, who desired to see the organization, still in its infancy, destroyed; the effective service of Jefferson Davis, in preventing the repudiation by the government of the responsibility which it had incurred by ordering the investment of the Smithson bequest in State bonds which had become worthless, and in securing the restoration to the Treasury of the money thus misapplied and lost; also the bold stand taken by Mr. Davis in 1850, in the Senate, resisting the demand to force upon the Institution the miscellaneous collection of curiosities then housed in the

Patent Office and called "The National Cabinet of Curiosities," without financial provision for its maintenance.

Reviewing the history of fifty years, one cannot fail to be impressed with the belief that Congress acted with great wisdom in determining the character of the corporation to which it intrusted the affairs of the Institution. It was at first proposed that the Directors of the Institution should be citizens, selected like those of private institutions, without reference to official connection with the government during their time of service. The plan finally adopted brought the Smithsonian Institution into much closer relationship with the government, securing for it the administrative supervision of a body of men the majority of whom have always been thoroughly representative members of the executive and legislative branches of the government; men in the prime of their vigor and trained to the highest administrative responsibilities. To be a Regent of the Institution has always been regarded as a high honor, and those who have held this position, as members of the Senate and House of Representatives, have been, without exception, eminent for scholarship and general culture, as well as in statesmanship. The citizen members of the Board associated with them have been equally eminent in the fields of scientific, literary, and educational work.

Being residents of Washington during their terms of service, the majority of this group of wise and experienced administrators had the opportunity of acquiring familiarity with the *activities* of the Institution from day to day, and have, without special effort, controlled and regulated all its work. Familiar with affairs, able to feel, almost unconsciously, the workings of manifold interests simultaneously in operation, in constant communication with the executive officers of the Establishment, the supervision which they have exercised has been of the most wholesome and effective character.

Notwithstanding the fears so generally entertained fifty years ago, the Institution has never, in any respect, fallen under the influence of political interference. No member of its staff has ever been appointed because of the influence of powerful friends or for any reason except that he was believed to be the best man available for the place. No sinecures have been created, and no breath of suspicion has ever tarnished the reputation of any officer or employee.

Since this can be said in regard to the first fifty years of the Smithsonian Institution, it may fairly be claimed as demonstrated that the plan of organization was wisely and judiciously conceived.

REGENTS OF THE SMITHSONIAN INSTITUTION

BIOGRAPHICAL NOTICES BY WILLIAM JONES RHEES

ROBERT ADAMS, JR.

PENNSYLVANIA.

Regent on behalf of the House of Representatives, appointed December 20, 1895.

Born in Philadelphia, Pennsylvania, February 26, 1849. A. B., University of Pennsylvania, 1869. Ph. B., Wharton School of Economy and Finance, University of Pennsylvania, 1884. Admitted to the Bar. Member of United States Geological Survey, 1871–'75. Member of Pennsylvania Senate, 1883–'87. U. S. Minister to Brazil, 1889–'90. Member of U. S. House of Representatives from Pennsylvania, January 3, 1894–March 4, 1899.

LOUIS AGASSIZ.

MASSACHUSETTS.

Regent elected by Congress, February 21, 1863; reëlected March 2, 1869.

Born in Motier, Canton Fribourg, Switzerland, May 28, 1807; died in Cambridge, Massachusetts, December 14, 1873. Educated in College of Lausanne, 1823. Studied medicine in Zurich, 1824, also in Heidelberg and Munich. M. D., Munich, 1829. Ph. D., Erlangen, 1830. LL. D., Edinburgh, 1834; Dublin, 1835; and Harvard, 1848. Member of French Academy of Sciences, 1836. Professor of Natural History in College of Neuchâtel, Switzerland, 1832. Professor of Zoölogy and Geology in Lawrence Scientific School, Cambridge, Massachusetts, 1848. Professor of Comparative Anatomy and Zoölogy in the Medical College, Charleston, South Carolina, 1851–'54. Curator of the Mu-

seum of Comparative Zoölogy, Cambridge, Massachusetts, 1859. Professor (non-resident) of Natural History, Cornell University, 1868. Director Penikese Island School of Natural History, 1873. Original member National Academy of Sciences, 1863. Received Monthyon prize from the Academy of Paris, and Wollaston medal from the London Geological Society.

JAMES BURRILL ANGELL.

MICHIGAN.

Regent elected by Congress, January 19, 1887; reëlected January 9, 1893.

Born in Scituate, Rhode Island, January 7, 1829. Educated in Seekonk, Massachusetts, and North Scituate, Rhode Island. A. B., Brown, 1849. LL. D., Brown, 1868; and Columbia, 1887. Professor of Modern Languages and Literature in Brown University, 1853. Editor *Providence Daily Journal*, 1860–'66. President of University of Vermont, 1866–'71. President of University of Michigan, 1871–'96. U. S. Minister to China, 1880–'82. Commissioner to negotiate a new treaty with China. Commissioner to form treaty with Great Britain in settlement of the fisheries dispute, 1887–'88.

CHESTER ALAN ARTHUR.

NEW YORK.

Regent *ex officio*, as Vice-President of the United States, March 4, 1881.

Born in Fairfield, Vermont, October 5, 1830; died in New York City, November 18, 1886. A. B., Union, 1848. LL. D., Princeton, 1884; and Union, 1884. Principal of an Academy in North Pownal, Bennington County, Vermont, 1851. Admitted to the Bar, New York, 1853. Engineer-in-Chief, as Brigadier-General on Governor Morgan's staff, January 1, 1861. Acting Quartermaster-General of New York. Inspector-General, 1862. Collector of the Port of New York, 1871–'78. Vice-President of the United States, 1881. President of the United States, July 20, 1881–'84.

WILLIAM BACKHOUSE ASTOR.

NEW YORK.

Regent elected by Congress, March 2, 1861.

Born in New York City, September 19, 1792; died in New York, November 24, 1875. Educated in public schools, New York; later in Heidelberg and Göttingen. Engaged with his father John Jacob Astor in trade with China, 1815–'27. President of the American Fur Company, 1827. Gave $550,000 to the Astor Library.

ALEXANDER DALLAS BACHE.

CITY OF WASHINGTON.

Regent elected by Congress, August 10, 1846; reëlected January 13, 1853, January 17, 1859.

Born in Philadelphia, Pennsylvania, July 19, 1806; died in Newport, Rhode Island, February 17, 1867. Graduated United States Military Academy, West

Point, New York, 1825. A. M., Yale, 1830. LL. D., University of the City of New York, 1836; University of Pennsylvania, 1837; and Harvard, 1851. Assistant Professor of Engineering in United States Military Academy, 1826. Lieutenant of Engineers, 1827–'29. Engaged in constructing Fort Adams and other public works. President of Girard College, Philadelphia, 1832–'39. Professor of Mathematics in University of Pennsylvania, 1827–'32. Professor of Natural Philosophy and Chemistry in University of Pennsylvania, 1828–'41, and 1842–'43. Principal of Central High School, Philadelphia, 1841–'42. Superintendent of Public Schools. Superintendent United States Coast Survey, November, 1843–'67. Vice-President United States Sanitary Commission. President American Philosophical Society, 1855. President American Association for the Advancement of Science, 1850. Original Member and President National Academy of Sciences, 1863.

GEORGE EDMUND BADGER.

NORTH CAROLINA.

Regent elected by Congress, February 27, 1856; reëlected January 17, 1859.

Born in Newbern, North Carolina, April 13, 1795; died in Raleigh, North Carolina, May 11, 1866. A. B., Yale, 1813. A. M., Yale, 1825. LL. D., University of North Carolina, 1834; and Yale, 1848. Admitted to the Bar in Raleigh, North Carolina. Major in War of 1812. North Carolina State Legislature, 1816–'20. Judge of North Carolina Superior Court, 1820–'25. Secretary of the Navy, March, 1841. Member of U. S. Senate from North Carolina, December 7, 1846–March 3, 1855.

GEORGE BANCROFT.

CITY OF WASHINGTON.

Regent elected by Congress, December 11, 1874.

Born in Worcester, Massachusetts, October 3, 1800; died in Washington City, January 17, 1891. Educated in Phillips Exeter Academy, New Hampshire. A. B., Harvard, 1817. Ph. D., University of Göttingen, 1820. D. C. L., Oxford, 1849. D. J., University of Bonn, 1868. LL.D., Harvard, 1843; and Union, 1840. L. H. D., Columbia, 1843. Tutor in Harvard. Principal of Round Hill School, Northampton, Massachusetts, 1824. Elected to Massachusetts Legislature, 1830. Collector of the Port of Boston, 1838–'41. Candidate for Governor of Massachusetts, 1844. Secretary of the Navy, 1845. Acting Secretary of War, 1846. U. S. Minister to Great Britain, 1846–'49. U. S. Minister to Prussia, 1867. U. S. Minister to North German Confederation, 1868. U. S. Minister to Germany, 1871–'74.

JAMES GABRIEL BERRET.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, June, 1858–June, 1860.

Born in Baltimore, Maryland, February 12, 1815. Member of House of Delegates of Maryland, 1837–'39. Clerk in Register of Treasury's office,

Washington City, 1839–'48. Chief Clerk of Pension Bureau, 1848–'49. Postmaster of Washington City, 1853–'58. Mayor of Washington City, 1858–'61. Appointed Commissioner by President Lincoln on Abolition of Slavery in the District of Columbia, 1862. Member of Washington Police Board, 1875–'77. Elector for Maryland, and President of the Electoral College, 1888. Member of Maryland Legislature and Chairman of Committee of Ways and Means, 1891. First Vice-President of Washington National Monument Society.

JOHN McPHERSON BERRIEN.

GEORGIA.

Regent elected by Congress, January 13, 1853.

Born in New Jersey, August 23, 1781; died in Savannah, Georgia, January 1, 1856. A. B., Princeton, 1796. LL. D., Princeton, 1829; University of Georgia, 1850; and University of Alabama, 1852. Admitted to the Bar in Georgia, 1799. Solicitor-General of Georgia, 1809. Judge of Eastern Circuit, 1810. Colonel in War of 1812. Member of Georgia Legislature, 1822. Member of U. S. Senate from Georgia, 1824–'29, 1840–'46, and 1847–'52. Attorney-General of United States, 1829. Judge of Supreme Court of Georgia, 1845–'47.

NEWTON BOOTH.

CALIFORNIA.

Regent on behalf of the Senate, appointed March 21, 1879.

Born in Salem, Indiana, December 25, 1825; died in Sacramento, California, July 14, 1892. A. B., Asbury University, 1846. LL. D., De Pauw, 1872. Admitted to the Bar in Terre Haute, Indiana, 1850. Member of California State Senate, 1863. Governor of California, 1871–'74. Member of U. S. Senate from California, March 9, 1875–March 3, 1881.

SAYLES JENKS BOWEN.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, June, 1868–June, 1870.

Born in Scipio, Cayuga County, New York, October 7, 1813; died in Washington City, December 16, 1896. Educated in Aurora Academy, New York. Clerk in United States Treasury Department, 1845–'48. Commissioner of Police in District of Columbia, 1861. Disbursing Officer of United States Senate, 1861. Collector of Internal Revenue, 1862. Postmaster City of Washington, 1863–'68. Mayor City of Washington, June, 1868–June, 1870. Trustee and Treasurer of Public Schools for Colored Children in the District of Columbia, to which he devoted much time, labor, and money.

JOHN CABELL BRECKINRIDGE.

KENTUCKY.

Regent *ex officio*, as Vice-President of the United States, March 4, 1857–March 4, 1861.

Born near Lexington, Kentucky, January 21, 1821; died in Lexington, Kentucky, May 17, 1875. A. B., Centre College, 1841. LL. D., Centre, 1857. Studied law at Transylvania Institute. Admitted to the Bar, Lexington, Kentucky. Major in Mexican War. Member of Kentucky Legislature. Member of U. S. House of Representatives from Kentucky, December 1, 1851–March 3, 1855. Declined the Spanish Mission. Vice-President of the United States, 1857. Member of U. S. Senate from Kentucky, March 4, 1861–December 4, 1861. Major-General Confederate Army, 1862.

WILLIAM CAMPBELL PRESTON BRECKINRIDGE.

KENTUCKY.

Regent on behalf of the House of Representatives, appointed January 15, 1892; reappointed January 4, 1894.

Born in Baltimore, Maryland, August 28, 1837. Admitted to the Bar in Louisville, Kentucky, 1857. Educated in Transylvania University and Centre College. LL. B., University of Louisville, 1857. A. M., Centre College, 1855. LL. D., Cumberland University, 1874, Central University, 1881; and Centre College, 1886. Captain and Colonel Confederate Army, 1862. Professor in Cumberland University. Member of U. S. House of Representatives from Kentucky, March 4, 1885–March 4, 1895.

SIDNEY BREESE.

ILLINOIS.

Regent on behalf of the Senate, appointed August 10, 1846.

Born in Whitesborough, New York, July 15, 1800; died in Pinckneyville, Illinois, June 27, 1878. Educated in Hamilton College. A. B., Union, 1818. LL. D., Union, 1871. Admitted to the Bar in Illinois, 1821. Assistant Secretary, State of Illinois. Postmaster of Kaskaskia, Illinois, 1800. Attorney-General of Illinois, 1822–'27. Attorney of the United States for Illinois, 1827. Lieutenant in Black Hawk War. Circuit Judge, 1835. Member of U. S. Senate from Illinois, December 4, 1843–March 3, 1849. Speaker of Illinois House of Representatives, 1850. Chief Judge of Circuit Court, Illinois, 1855. Justice of Supreme Court of Illinois, 1857–'78.

BENJAMIN BUTTERWORTH.

OHIO.

Regent on behalf of the House of Representatives, appointed January 6, 1890.

Born in Warren County, Ohio, October 22, 1837. Educated in public schools and Ohio University. Graduated in Cincinnati Law College, 1861. Admitted to the Bar. Member of Ohio Senate, 1873–'75. Member of U. S.

House of Representatives from Ohio, March 18, 1879–March 3, 1883, December 7, 1885–March 4, 1891. U. S. Commissioner of Patents, 1883. Secretary and Solicitor-General of the World's Columbian Exposition in Chicago.

LEWIS CASS.

MICHIGAN.

Regent on behalf of the Senate, appointed January 18, 1847.

Born in Exeter, New Hampshire, October 9, 1782; died in Detroit, Michigan, June 17, 1866. Educated in Exeter Academy. LL. D, Hamilton, 1825; Harvard, 1836; and Jefferson, 1837. Admitted to the Bar in Marietta, Ohio, 1802. Member of Ohio Legislature, 1807. Marshal of Ohio, 1807–'13. Colonel and Brigadier-General in War of 1812. Governor of Michigan, 1813–'31. Secretary of War, 1831–'36. Minister to France, 1836–'42. Member of U. S. Senate from Michigan, December 1, 1845–August 14, 1848, December 3, 1849–March 3, 1851. Secretary of State, 1857–'60. Negotiated many treaties with the Indians. Candidate for President, 1848.

ROBERT MILLEDGE CHARLTON.

GEORGIA.

Regent on behalf of the Senate, appointed August 24, 1852.

Born in Savannah, Georgia, January 19, 1807; died in Savannah, Georgia, January 18, 1854. Admitted to the Bar, 1825. Member of Georgia Legislature. U. S. District Attorney. Judge of the Supreme Court of Eastern Georgia, 1834. Member of U. S. Senate from Georgia, December 6, 1852–March 3, 1853. Mayor of Savannah, Georgia.

SALMON PORTLAND CHASE.

OHIO.

Regent *ex officio,* as Chief Justice of the United States, December 6, 1864.

Born in Cornish, New Hampshire, January 13, 1808; died in Washington City, May 7, 1873. Educated in Cincinnati College. A. B., Dartmouth, 1826. LL. D., Miami, 1865. Admitted to the Bar, 1829. Member of U. S. Senate from Ohio, December 3, 1849–March 3, 1855. Governor of Ohio, 1855–'57. Elected to U. S. Senate from Ohio, 1860. Secretary of the Treasury, 1861–'64. Chief Justice of the United States, 1864–'73.

RUFUS CHOATE.

MASSACHUSETTS.

Regent elected by Congress, August 10, 1846; reëlected December 19, 1848, and December 27, 1854.

Born in Ipswich, Massachusetts, October 1, 1799; died in Halifax, Nova Scotia, July 12, 1859. Tutor in Dartmouth College. A. B. and A. M., Dartmouth, 1819. LL. D., Yale, 1844; Harvard, 1845; Dartmouth, 1845; and Amherst, 1848. Studied law in Cambridge, Massachusetts, and Washington City. Admitted to the Bar in Danvers, Massachusetts, 1824. Member of

Massachusetts Legislature, 1825-'28. Member of U. S. House of Representatives from Massachusetts, December 6, 1830–July 30, 1834. Member of U. S. Senate from Massachusetts, May 31, 1841–August 10, 1846.

NATHAN CLIFFORD.

MAINE.

Regent *ex officio*, as Acting Chief Justice of the United States, May 7, 1873, and Chancellor *pro tem.* pending the appointment of a Chief Justice.

Born in Rumney, New Hampshire, August 18, 1803; died in Cornish, Maine, July 25, 1881. Educated in Haverhill Academy and Hampton Literary Institution. LL. D., Bowdoin, 1860; Dartmouth, 1862; Brown, 1868; and Harvard, 1878. Admitted to the Bar in New Hampshire, 1827. Member of Maine Legislature and Speaker, 1830–'34. Attorney-General of Maine, 1834–'38. Member of U. S. House of Representatives from Maine, December 2, 1839–March 3, 1843. Attorney-General of the United States, 1846–'48. Commissioner to Mexico, 1849. U. S. Minister to Mexico, 1848–'49. Justice of United States Supreme Court, 1858–'81. Member of the Electoral Commission, 1876.

HIESTER CLYMER.

PENNSYLVANIA.

Regent on behalf of the House of Representatives, appointed December 14, 1875; reappointed January 14, 1878, and April 4, 1879.

Born in Berks County, Pennsylvania, November 3, 1827; died in Reading, Pennsylvania, June 12, 1884. Educated in public schools, Reading. A. B., Princeton, 1847. Admitted to the Bar, 1849. Member of Pennsylvania Legislature, 1860. Candidate for Governorship of Pennsylvania, 1866. Member of the State Board of Public Charities, 1870. Member of U. S. House of Representatives from Pennsylvania, December 1, 1873–March 4, 1881.

WILLIAM FERGUSON COLCOCK.

SOUTH CAROLINA.

Regent on behalf of the House of Representatives, appointed January 7, 1850; reappointed January 2, 1852, and January 11, 1853.

Born in Beaufort, South Carolina, November 5, 1804; died in Charleston, South Carolina, June 13, 1889. A. B., South Carolina College, 1823. Admitted to the Bar. Member of South Carolina Legislature. Speaker of South Carolina House. Member of U. S. House of Representatives from South Carolina, December 3, 1849–March 3, 1853. Collector of Port of Charleston.

SCHUYLER COLFAX.

INDIANA.

Regent on behalf of the House of Representatives, appointed December 19, 1861. Regent *ex officio*, as Vice-President of the United States, March 4, 1869–March 4, 1873.

Born in New York City, March 23, 1823; died in Mankato, Minnesota, January 13, 1885. Educated in public schools, New York City. Ad-

mitted to the Bar, Indiana, 1836. Member of Indiana State Constitutional Convention, 1850. Member of U. S. House of Representatives from Indiana, December 3, 1855–March 4, 1869. Speaker of the U. S. House of Representatives, 1863–'68. Vice-President of the United States, March 4, 1869–March 4, 1873.

HENRY DAVID COOKE.

CITY OF WASHINGTON.

Regent *ex officio*, as Governor of the District of Columbia, February 28, 1871–September 13, 1873.

Born in Sandusky, Ohio, November 23, 1825; died in Georgetown, District of Columbia, February 24, 1881. Educated in Allegheny College. A. B., Transylvania University, 1844. Admitted to the Bar in Sandusky, Ohio, and Philadelphia, Pennsylvania. Attaché to American Consul in Valparaiso, Chile, 1846. Presidential Elector, 1856. Journalist in Philadelphia, Sandusky, and Columbus, Ohio. First Governor of District of Columbia, February 28, 1871–September 13, 1873.

HENRY COPPÉE.

PENNSYLVANIA.

Regent elected by Congress, January 19, 1874; reëlected December 19, 1879, December 26, 1885, and January 26, 1892.

Born in Savannah, Georgia, October 13, 1821; died in Bethlehem, Pennsylvania, March 22, 1895. Educated in Yale, 1839. Graduated United States Military Academy, 1845. A. M., University of Georgia, 1848. LL. D., Union, 1866; and University of Pennsylvania, 1866. Served through Mexican War, brevetted Captain, 1847. Professor of French, 1848–'49; Professor of Geography, History, and Ethics, 1850–'55; Assistant Professor of Geography, History, and Ethics, U. S. Military Academy, 1855. Professor of English Literature and History, University of Pennsylvania, 1855–'66. President of Lehigh University, 1866–'79, '90, '93–'95. Professor of English Literature and History, and of International and Constitutional Law, Lehigh University, 1874–'95. U. S. Assay Commissioner, 1874 and 1880.

SAMUEL SULLIVAN COX.

OHIO–NEW YORK.

Regent on behalf of the House of Representatives, appointed December 19, 1861; reappointed December 23, 1863, February 2, 1870, December 18, 1873, January 9, 1882, and January 5, 1888.

Born in Zanesville, Ohio, September 30, 1824; died in New York City, September 10, 1889. Educated in public schools, Zanesville, Ohio. A. B., Brown University, 1846. A. M., Brown. LL. D., Brown, 1885. Admitted to the Bar, Cincinnati, Ohio. Secretary of Legation to Peru, 1855. Member of U. S. House of Representatives from Ohio, December 6, 1857–March 3, 1865. Member of U. S. House of Representatives from New York, March 4, 1869–March 3, 1885, December 5, 1887–March 3, 1889. U. S. Minister to Turkey, 1885–'86.

SHELBY MOORE CULLOM.

ILLINOIS.

Regent on behalf of the Senate, appointed March 23, 1885; reappointed March 28, 1889, and December 18, 1895.

Born in Wayne County, Kentucky, November 22, 1829. Educated in Rock River Seminary, Mount Morris, Illinois. Admitted to the Bar in Springfield, Illinois, 1855. City Attorney of Springfield, 1855. Presidential Elector, 1856. Member of the Illinois Legislature, 1856–'60, 1872–'74, and its Speaker, 1861, '73. Member of U. S. House of Representatives from Illinois, December 4, 1865–March 3, 1871. Governor of Illinois, January 8, 1877–February 5, 1883. Member of U. S. Senate from Illinois, December 4, 1883–March 3, 1901.

GEORGE MIFFLIN DALLAS.

PENNSYLVANIA.

Regent *ex officio*, as Vice-President of the United States, August 10, 1846–March 4, 1849.

Born in Philadelphia, July 10, 1792; died in Philadelphia, December 31, 1864. A. B., Princeton, 1810. LL. D., Princeton, 1854. Admitted to the Bar, 1813. Secretary of the Russian Commission, 1813–'14. Deputy Attorney-General for Philadelphia County, 1817. Mayor of Philadelphia, 1829. U. S. Attorney for Pennsylvania, 1829–'31. Member of U. S. Senate from Pennsylvania, December 5, 1831–March 2, 1833. Attorney-General of Pennsylvania, 1833–'35. U. S. Minister to Russia, 1837–'39. Vice-President of the United States, 1845–'49. U. S. Minister to Great Britain, 1856–'61.

JAMES DWIGHT DANA.

CONNECTICUT.

Regent elected by Congress, January 19, 1874; resigned December 27, 1877.

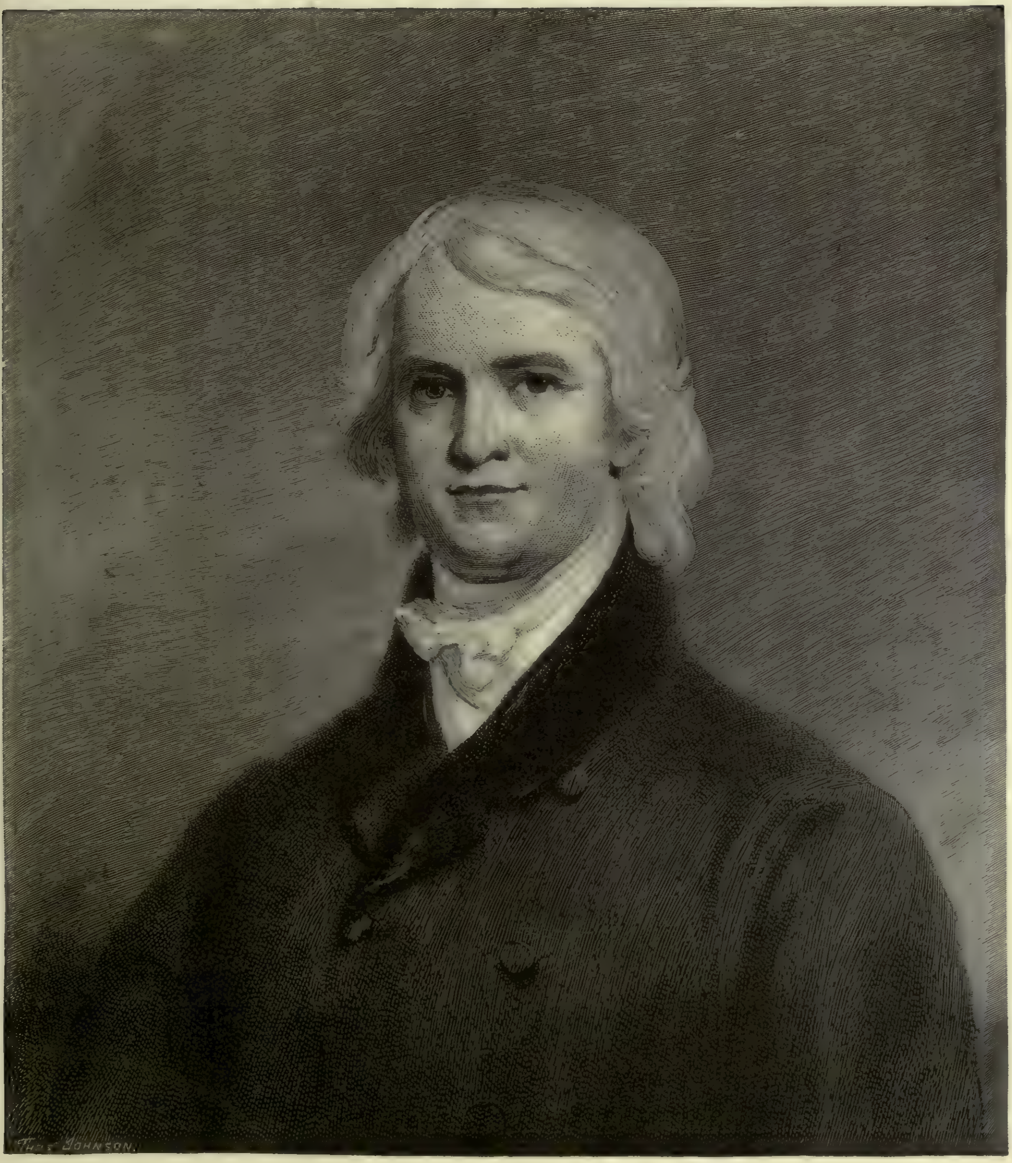
Born in Utica, New York, February 13, 1813; died in New Haven, Connecticut, April 14, 1895. Educated in Bartlett Academy, Utica, New York. A. B., Yale, 1833. Ph. D., Munich, 1872. LL. D., Amherst, 1853; Harvard, 1886; and Edinburgh, 1889. Instructor of Mathematics to United States Naval Officers, 1833–'36. Assistant in Chemistry, Yale, 1836–'38. Mineralogist, Geologist, and Zoölogist of the United States Exploring Expedition, 1836–'42. Silliman Professor of Natural History and Geology in Yale, 1850–'90. Editor of *American Journal of Science*, 1846–'95. Received Wollaston and Copley medals and Grand Walker prize. President of American Association for the Advancement of Science, 1854. Original Member National Academy of Sciences, 1863.

DAVID DAVIS.

ILLINOIS.

Regent *ex officio*, as President of the Senate *pro tem.*, October 13, 1881–March 4, 1883.

Born in Cecil County, Maryland, March 9, 1815; died in Bloomington, Illinois, June 26, 1886. Educated in Newark Academy. A. B., Kenyon,


THOS JOHNSON.

1832. LL. D., Williams, 1873; Beloit; and Illinois Wesleyan. Studied law in New Haven. Admitted to the Bar, Pekin, Illinois, 1835. Member of Illinois Legislature, 1844. Member of State Constitutional Convention, 1847. Judge of 8th Circuit, 1848–'62. Justice of the U. S. Supreme Court, 1862–'77. Member of U. S. Senate from Illinois, December 3, 1877–March 3, 1883. President of the Senate *pro tem.*, 1881–'83.

GARRETT DAVIS.

KENTUCKY.

Regent on behalf of the Senate, appointed January 16, 1863; reappointed March 21, 1867.

Born in Mount Sterling, Kentucky, September 10, 1801; died in Paris, Kentucky, September 22, 1872. Admitted to the Bar, 1823. Member of Kentucky Legislature, 1833–'36. Member of State Constitutional Convention, 1839–'47. Member of U. S. House of Representatives from Kentucky, March 4, 1847–March 3, 1849. Member of U. S. Senate from Kentucky, December 3, 1861–September 22, 1872.

HENRY WINTER DAVIS.

MARYLAND.

Regent on behalf of the House of Representatives, appointed December 23, 1863.

Born in Annapolis, Maryland, August 16, 1817; died in Baltimore, Maryland, December 30, 1865. A. B., Kenyon, 1837. LL. D., Hampden-Sidney. Studied law in University of Virginia. Admitted to the Bar, Alexandria, Virginia, and Baltimore, Maryland. Member of U. S. House of Representatives from Maryland, December 3, 1855–June 14, 1858, December 7, 1863–March 3, 1865.

JEFFERSON DAVIS.

MISSISSIPPI.

Regent on behalf of the Senate, appointed December 30, 1847; reappointed March 6, 1851.

Born in Christian County, Kentucky, June 3, 1808; died in New Orleans, Louisiana, December 6, 1889. Educated in Transylvania College. Graduated United States Military Academy, 1828. LL. D., Bowdoin, 1858. Served in Black Hawk War, 1831–'32; Mexican War, 1846. Second Lieutenant Infantry, 1828–'33. First Lieutenant Dragoons, 1833–'35. Member of U. S. House of Representatives from Mississippi, December 8, 1845–August 10, 1846. Member of U. S. Senate from Mississippi, December 6, 1847–March 3, 1851, December 7, 1857–March 2, 1861. Secretary of War, 1853–57. Major-General and President of the Confederate States, 1861.

WILLIAM LEWIS DAYTON.

NEW JERSEY.

Regent elected by Congress, March 2, 1861.

Born in Baskinridge, New Jersey, February 17, 1807; died in Paris, France, December 1, 1864. A. B., Princeton, 1825. LL. D., Princeton, 1857. Ad-

mitted to the Bar, Trenton, New Jersey, 1830. Member of the New Jersey Legislature, 1837. Associate Judge of the Supreme Court of the State, 1838. Member of U. S. Senate from New Jersey, December 5, 1842–March 3, 1851. Attorney-General of New Jersey, 1857–'61. U. S. Minister to France, 1861–'64. Candidate for Vice-President, 1856.

NATHANIEL COBB DEERING.

IOWA.

Regent on behalf of the House of Representatives, appointed January 9, 1882.

Born in Denmark, Oxford County, Maine, September 2, 1827; died in Osage, Iowa, December 8, 1887. Educated in public schools and North Bridgeton Academy, Maine. Member of Maine Legislature, 1855–'56. Removed to Osage, Iowa, 1857. Clerk in U. S. Senate, 1862–'65. Special Agent in Post Office Department, 1865–'69. National Bank Examiner for Iowa, 1872–'77. Member of U. S. House of Representatives from Iowa, October 15, 1877–March 3, 1883.

RICHARD DELAFIELD.

CITY OF WASHINGTON.

Regent elected by Congress, February 14, 1865.

Born in New York City, September 1, 1798; died in Washington City, November 5, 1873. Graduated United States Military Academy, 1818. Served in Engineer works, 1819–'38. Superintendent of United States Military Academy, 1838–'45, 1856–'61. Superintended the defenses of New York Harbor, 1846–'55. Brigadier-General and Chief of Engineers, 1864–'70. Major-General, 1865.

CHARLES DEVENS.

MASSACHUSETTS.

Regent elected by Congress, May 20, 1890.

Born in Charlestown, Massachusetts, April 4, 1820; died in Boston, Massachusetts, January 7, 1891. Declined appointment as Regent on account of a provision in Constitution of the State of Massachusetts that "Justices of the Supreme Judicial Court of the Commonwealth shall not hold any other place or office, or receive any pension or salary from any other State, Government, or power whatsoever." A. B., Harvard, 1838. LL. D., Columbian, 1876; and Harvard, 1877. Studied law in Cambridge. Admitted to the Bar, 1841. Member of Massachusetts Legislature, 1848–'49. U. S. Marshal for Massachusetts, 1849–'53. Major, Colonel, Brigadier-General, 1861–'62. Major-General, 1864. Justice of Superior Court of Massachusetts, 1867. Justice of Supreme Court of Massachusetts, 1873–'77, '81. Attorney-General of the United States, 1877.

STEPHEN ARNOLD DOUGLAS.

ILLINOIS.

Regent on behalf of the Senate, appointed February 21, 1854; reappointed January 26, 1860.

Born in Brandon, Vermont, April 23, 1813; died in Chicago, Illinois, June 3, 1861. Educated in public schools, Brandon, Vermont, and Canandaigua, New York. Taught school in Winchester, Illinois, 1833. Admitted to the Bar, 1834. Attorney-General of the State of Illinois, 1834. Member of the Illinois Legislature, 1835. Secretary of State of Illinois, 1840. Judge of the Supreme Court, 1841. Registrar of the Land Office of Illinois, 1837. Member of U. S. House of Representatives from Illinois, December 4, 1843–August 10, 1846. Member of U. S. Senate from Illinois, December 6, 1847–March 2, 1861. Candidate for President of the United States, 1860.

GEORGE FRANKLIN EDMUNDS.

VERMONT.

Regent on behalf of the Senate, appointed January 20, 1883; declined February, 21, 1883. Regent *ex officio*, as President of the Senate *pro tem.*, 1883–'85.

Born in Richmond, Vermont, February 1, 1828. Educated in public schools. A. M., University of Vermont, 1855. LL. D., Middlebury, 1869; and University of Vermont, 1879. Admitted to the Bar in Richmond, Vermont, 1849. Member of Vermont Legislature, 1854–'59, 1861–'62; and Speaker, 1855–'57. Member of U. S. Senate from Vermont, December 3, 1866–March 3, 1891. President *pro tem.* of the United States Senate, 1883–'85.

MATTHEW GAULT EMERY.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, June, 1870–June, 1871.

Born in Pembroke, New Hampshire, September 28, 1818. Educated in Pembroke Academy. Member of Board of Aldermen, Washington City, many years. Captain of Company of Militia in the District of Columbia, May 16, 1861. Treasurer of New Hampshire Soldiers' Association, 1861–'65. Trustee Dickinson College, Pennsylvania. Mayor of Washington City, June, 1870–June, 1871. Vice-Chancellor of National University, Regent and Treasurer American University, Washington City.

WILLIAM HAYDEN ENGLISH.

INDIANA.

Regent on behalf of the House of Representatives, appointed December 14, 1853; reappointed February 26, 1856, December 14, 1857, February 21, 1860.

Born in Lexington, Indiana, August 27, 1822; died in Indianapolis, Indiana, February 7, 1896. Educated in Hanover College. Admitted to the Bar, 1846. County Clerk; Postmaster in Lexington. Secretary of Indiana

State Constitutional Convention, 1850. Member and Speaker of Indiana Legislature, 1851. Member of U. S. House of Representatives from Indiana, December 1, 1851–March 4, 1861. Candidate for Vice-President, 1880. President Indiana Historical Society.

GEORGE EVANS.

MAINE.

Regent on behalf of the Senate, appointed August 10, 1846.

Born in Hallowell, Maine, January 12, 1797; died in Portland, Maine, April 5, 1867. Educated in Hallowell and Monmouth Academies, Maine. A. B., Bowdoin, 1815. LL. D., Bowdoin, 1847. Admitted to the Bar in Gardiner, Maine, 1818. Member of Maine Legislature, 1825–'28, and Speaker, 1828. Member of U. S. House of Representatives from Maine, December 7, 1829–March 3, 1841. Member of U. S. Senate from Maine, May 31, 1841–March 3, 1847. Attorney-General of Maine, 1853–'56. Commissioner of Board of Mexican Claims, 1849–'50.

JOHN FRANKLIN FARNSWORTH.

ILLINOIS.

Regent on behalf of the House of Representatives, appointed December 21, 1865.

Born in Eaton, Quebec, Canada, March 27, 1820. Admitted to the Bar and practised law in Chicago. Member of U. S. House of Representatives from Illinois, December 1, 1857–March 4, 1861, December 7, 1863–March 4, 1873. Colonel, Brigadier-General, 1862–'63.

CORNELIUS CONWAY FELTON.

MASSACHUSETTS.

Regent elected by Congress, February 27, 1856; reëlected March 2, 1861.

Born in West Newbury, Massachusetts, November 6, 1807; died in Chester, Pennsylvania, February 26, 1862. Educated in Franklin Academy, Andover. A. B., Harvard, 1827. LL. D., Amherst, 1848; and Yale, 1860. Latin tutor, 1829; Greek tutor, 1830; Professor of Greek, 1832; Professor of Greek Literature, 1834; President of Harvard College, 1860–'62.

THOMAS WHITE FERRY.

MICHIGAN.

Regent *ex officio*, as President of the Senate *pro tem.*, Acting Vice-President, December 20, 1875.

Born in Mackinac, Michigan, June 1, 1827; died in Grand Haven, Michigan, October 14, 1896. Educated in public school. Member of Michigan Legislature, 1850–'56. Member of U. S. House of Representatives from Michigan, December 4, 1865–March 3, 1871. Member of U. S. Senate from Michigan, March 4, 1871–March 3, 1883. President *pro tem.* United States Senate, 1875–'79. As Acting Vice-President presided and delivered the ad-

dress in Centennial Exhibition, Philadelphia, 1876. Presided at impeachment trial of Secretary Belknap and the Joint Electoral Commission, 1876–'77.

WILLIAM PITT FESSENDEN.

MAINE.

Regent on behalf of the Senate, appointed December 4, 1861; reappointed March 7, 1865.

Born in Boscawen, New Hampshire, October 16, 1806; died in Portland, Maine, September 8, 1869. A. B., Bowdoin, 1823. LL. D., Bowdoin, 1858; and Harvard, 1864. Admitted to the Bar, Bridgeton, Maine, 1827. Member of Maine Legislature, 1832–'40, 1845–'46, and 1853–'54. Presidential Elector, 1852. Member of U. S. House of Representatives from Maine, May 31, 1841–March 3, 1845. Member of U. S. Senate from Maine, July 4, 1854–December 6, 1864, December 4, 1865–April 10, 1869. Secretary of the Treasury, July, 1864–March, 1865.

MILLARD FILLMORE.

NEW YORK.

Regent *ex officio*, as Vice-President of the United States, March 4, 1849–1850.

Born in Summer Hill, Cayuga County, New York, February 7, 1800; died in Buffalo, New York, March 7, 1874. D. C. L., University of Oxford. Admitted to the Bar, Buffalo, New York, 1823. Member of the New York Legislature, 1828–'32. Member of U. S. House of Representatives from New York, December 2, 1833–March 3, 1835, September 4, 1837–March 3, 1843. Comptroller of the State of New York, 1847. Vice-President of the United States, March 4, 1849. President of the United States, July 9, 1850.

GRAHAM NEWELL FITCH.

INDIANA.

Regent on behalf of the House of Representatives, appointed January 7, 1850; reappointed January 2, 1852.

Born in LeRoy, New York, December 6, 1809; died in Logansport, Indiana, November 29, 1892. Educated in Middlebury and Geneva, New York. M. D., Medical College, Fairfield, New York. Practised medicine in Logansport, Indiana, 1834. Professor in Rush Medical College, Chicago, 1844–'49. Professor of Surgery, Indiana Medical College, 1878–'83. Member of Indiana Legislature, 1836–'39. Member of U. S. House of Representatives from Indiana, December 3, 1849–March 3, 1853. Member of U. S. Senate from Indiana, December 7, 1857–March 2, 1861. Colonel in War of the Rebellion, 1861–'62. Presidential Elector, 1844, 1848, 1856.

LAFAYETTE SABINE FOSTER.

CONNECTICUT.

Regent as President of the Senate, Acting Vice-President *pro tem.*, April 15, 1865.

Born in Franklin, Connecticut, November 22, 1806; died in Norwich, Connecticut, September 19, 1880. A. B., Brown, 1828. LL. D., Brown,

1851. Admitted to the Bar, Centerville, Maryland, and Norwich, Connecticut, 1830, '31. Member of the Connecticut Legislature, 1839–'41, 1846–'48, and 1854–'70; and Speaker, 1847–'48, 1854, and 1870. Mayor of Norwich, Connecticut, 1851–'52. Member of U. S. Senate from Connecticut, March 4, 1855–March 4, 1867. President of the Senate *pro tem.*, 1865–'67. Justice of Supreme Court of Connecticut, 1870–'76. Professor of Law in Yale, 1869.

MELVILLE WESTON FULLER.

ILLINOIS.

Regent *ex officio*, as Chief Justice of the United States, October 8, 1888.

Born in Augusta, Maine, February 11, 1833. A. B., Bowdoin, 1853. LL. D., Northwestern University; Bowdoin, 1888; and Harvard, 1890. Studied law in Bangor and at Harvard. Admitted to the Bar, 1855. President of Council of Augusta and City Solicitor, 1856. Member of Illinois Constitutional Convention, 1862. Member of Illinois Legislature, 1863–'65. Chief Justice of the United States, 1888.

JAMES ABRAM GARFIELD.

OHIO.

Regent on behalf of the House of Representatives, appointed December 21, 1865; reappointed January 7, 1868, February 2, 1870, January, 1872, January 14, 1878, April 14, 1879.

Born in Bedford, Cuyahoga County, Ohio, November 19, 1831; died in Elberon, New Jersey, September 19, 1881. Educated in high schools, Chester and Hiram, Ohio. A. B., Williams, 1856. A. M., Williams, 1859. LL. D., Williams, 1872; and University of Pennsylvania, 1881. Tutor of Latin and Greek in Hiram College, 1856. President of Hiram College, 1857–'59. Member of Ohio Senate, 1859–'60. Lieutenant-Colonel, Colonel, Brigadier-General, Major-General, 1861–'63. Member of U. S. House of Representatives from Ohio, December 7, 1863–June 16, 1880. Elected to U. S. Senate from Ohio, 1880. President of the United States, March 4, 1881.

LUCIUS JEREMIAH GARTRELL.

GEORGIA.

Regent on behalf of the House of Representatives, appointed December 14, 1857; reappointed February 21, 1860.

Born in Wilkes County, Georgia, January 7, 1821; died in Atlanta, Georgia, April 7, 1891. Educated in Randolph-Macon, Virginia, and Franklin College, now University of Georgia. Admitted to the Bar, 1842. Solicitor-General of Georgia, 1843–'47. Member of Georgia Legislature, 1847–'51. Presidential Elector, 1856. Member of U. S. House of Representatives from Georgia, December 7, 1857–March 2, 1861. Colonel and Brigadier-General in Confederate Army.

RANDALL LEE GIBSON.

LOUISIANA.

Regent on behalf of the Senate, appointed December 19, 1887; reappointed March 28, 1889.

Born in Spring Hill, Kentucky, September 10, 1832; died in Hot Springs, Arkansas, December 15, 1892. Educated in Lexington, Kentucky, and Terre Bonne, Louisiana. A. B., Yale, 1853. Graduated in law, University of Louisiana, 1855. Declined Secretaryship of Legation to Spain, 1855. Captain, Colonel, and General in Confederate Army. Member of U. S. House of Representatives from Louisiana, December 6, 1875–March 3, 1883. Member of U. S. Senate from Louisiana, March 4, 1883–March 3, 1892. President of the Board of Administration of the Tulane Educational Fund. Trustee of the Peabody Educational Fund. Administrator of the Howard Memorial Library.

ASA GRAY.

MASSACHUSETTS.

Regent elected by Congress, January 19, 1874: reëlected December 19, 1879, and December 26, 1885.

Born in Paris, New York, November 18, 1810; died in Cambridge, Massachusetts, January 30, 1888. Educated in Fairfield Academy, New York, 1825–'29. M. D., College of Physicians and Surgeons, Fairfield, 1831. A. M., Harvard, 1844. LL. D., Hamilton, 1860. Harvard, 1875; McGill, 1884; University of Michigan, 1887; and Edinburgh, 1887. D. Sc., Cambridge, 1887. D. C. L., Oxford, 1887. Botanist to United States Exploring Expedition, 1834–'37. Curator New York Lyceum of Natural History, 1836. Elected Professor of Botany and Zoölogy, University of Michigan (declined), 1838. Professor of Natural History, Harvard, 1842–'73. Curator of the Herbarium, Harvard, 1873. Original Member of National Academy of Sciences, 1863. President of the American Academy of Arts and Sciences, 1863–'73. President of the American Association for the Advancement of Science, 1872.

GEORGE GRAY.

DELAWARE.

Regent on behalf of the Senate, appointed December 20, 1892; reappointed March 20, 1893.

Born in New Castle, Delaware, May 4, 1840. A. B., Princeton, 1859. A. M., Princeton, 1862. LL. D., Princeton, 1889. Studied law in Harvard. Admitted to the Bar, 1863. Attorney-General of Delaware, 1879–'85. Member of U. S. Senate from Delaware, March 19, 1885–March 3, 1899.

HANNIBAL HAMLIN.

MAINE.

Regent *ex officio*, as Vice-President of the United States, March 4, 1861–March 4, 1865. Regent on behalf of the Senate, appointed January 18, 1870.

Born in Paris, Maine, August 27, 1809; died in Bangor, Maine, July 4, 1891. Educated in Hebron Academy, Maine. LL. D., Waterville (now Colby) University, 1859. Admitted to the Bar, Paris, Maine, 1833. Mem-

ber of the Maine Legislature, 1836–'40, and 1847. Speaker of the Maine House, 1837–'39, and 1840. Member of U. S. House of Representatives from Maine, December 4, 1843–March 3, 1847. Member of U. S. Senate from Maine, June 12, 1848–March 3, 1851, March 3, 1857–March 3, 1861, March 3, 1869–March 3, 1881. Governor of Maine, 1857. Vice-President of the United States, 1861–'65. Collector of Port of Boston, 1865–'66. U. S. Minister to Spain, 1881–'85.

GIDEON HAWLEY.

NEW YORK.

Regent elected by Congress, August 10, 1846; reëlected December 19, 1848, and December 27, 1854.

Born in Huntington, Connecticut, September 26, 1785; died in Albany, New York, July 16, 1870. Educated in Academy, Ballston, New York. A. B., Union, 1809. LL. D., Rutgers, 1833. Admitted to the Bar in Albany, 1813. Secretary of the Regents of the University of New York, 1814–'41. State Superintendent of Common Schools, 1813–'21; known as "the Father of the Common School System of the State." Regent of the University of New York, 1842–'70. Trustee of Albany Academy, 1818. Trustee of Albany Female Academy, 1821. Member of Executive Committee of State Normal School, 1845–'52. Master in Chancery, 1812.

GERRY WHITING HAZLETON.

WISCONSIN.

Regent on behalf of the House of Representatives, appointed December 18, 1873.

Born in Chester, New Hampshire, February 24, 1829. Educated in Pinkerton Academy, New Hampshire. Admitted to the Bar, 1856. Member of Wisconsin Senate, 1860. Collector of Internal Revenue, 1866. U. S. Attorney for Wisconsin, 1869. Member of U. S. House of Representatives from Wisconsin, March 4, 1871–March 3, 1875.

JOHN BROOKS HENDERSON.

CITY OF WASHINGTON.

Regent elected by Congress, January 26, 1892.

Born near Danville, Virginia, November 16, 1826. LL. D., University of Missouri, 1882. Admitted to the Bar in Missouri, 1848. Member of Missouri Legislature, 1856. Presidential Elector, 1856–'60. Member of U. S. Senate from Missouri, January 29, 1862–March 3, 1869. Commissioner to the Indians, 1867. Assistant U. S. District Attorney, 1875.

THOMAS ANDREWS HENDRICKS.

INDIANA.

Regent *ex officio*, as Vice-President of the United States, March 4, 1885.

Born in Muskingum County, Ohio, September 7, 1819; died in Indianapolis, Indiana, November 25, 1885. A. B., South Hanover College 1841. Admitted to the Bar in Shelbyville, Indiana, 1843. Member of Indiana Legis-

lature, 1845. Member of Constitutional Convention, 1850. Member of U. S. House of Representatives from Indiana, December 1, 1851–March 4, 1853. Commissioner of the General Land Office, 1855–'57. Member of U. S. Senate from Indiana, December 7, 1863–March 3, 1869. Governor of Indiana, 1873–'77. Vice-President of the United States, 1885.

BENJAMIN HARVEY HILL.

GEORGIA.

Regent on behalf of the House of Representatives, appointed December 14, 1875.

Born in Hillsborough, Jasper County, Georgia, September 14, 1823; died in Atlanta, Georgia, August 19, 1882. A. B., University of Georgia, 1844. Admitted to the Bar in La Grange, Georgia, 1845. Member of the Georgia House of Representatives, 1851; and Senate, 1859. Member of Confederate Senate, 1861–'65. Member of U. S. House of Representatives from Georgia, December 6, 1875–March 3, 1879. Member of U. S. Senate from Georgia, March 5, 1877–August 19, 1882. Presidential Elector, 1856, 1860.

NATHANIEL PETER HILL.

COLORADO.

Regent on behalf of the Senate, appointed May 19, 1881.

Born in Montgomery, New York, February 18, 1832. A. B., Brown, 1856. Tutor in Chemistry, 1858; Professor of Chemistry applied to the Arts, 1859–'64, Brown University. Member of the Colorado Territorial Council, 1872–'73. Mayor of Black-Hawk, Colorado, 1871. Member of U. S. Senate from Colorado, March 3, 1879–March 3, 1885. Member of International Monetary Commission, 1891.

HENRY WASHINGTON HILLIARD.

ALABAMA.

Regent on behalf of the House of Representatives, appointed August 10, 1846; re-appointed December 22, 1847, and January 7, 1850.

Born in Fayetteville, North Carolina, August 4, 1808; died in Atlanta, Georgia, December 17, 1892. A. B., South Carolina College, 1826. A. M., South Carolina College, 1829; and University of Alabama, 1834. Admitted to the Bar in Athens, Georgia, 1829. Professor in Alabama University, 1831–'34. Member of Alabama Legislature, 1838. U. S. Minister to Belgium, 1842–'44. Member of U. S. House of Representatives from Alabama December 1, 1845–March 3, 1851. U. S. Minister to Brazil, 1877–'81, Presidential Elector, 1840, 1856, 1860. Brigadier-General in Confederate Army, 1862.

ROBERT ROBERTS HITT.

ILLINOIS.

Regent on behalf of the House of Representatives, appointed August 11, 1893; re-appointed January 4, 1894, and December 20, 1895.

Born in Urbana, Ohio, January 16, 1834. Educated in Rock River Seminary (now Mount Morris College), Illinois. A. B., De Pauw University, 1855.

A. M., De Pauw, 1858. LL. D., De Pauw, 1894. First Secretary of Legation and Chargé d'Affaires *ad interim* at Paris, December, 1874–March, 1881. Assistant Secretary of State, 1882. Member of U. S. House of Representatives from Illinois, November 7, 1882–March 3, 1899.

EBENEZER ROCKWOOD HOAR.

MASSACHUSETTS.

Regent on behalf of the House of Representatives, appointed December 18, 1873.

Born in Concord, Massachusetts, February 21, 1816; died in Concord, Massachusetts, January 31, 1895. A. B., Harvard, 1835. LL. B., Harvard, 1839. LL. D., Williams, 1861; and Harvard, 1868. Admitted to the Bar in Concord and Boston, 1840. Member of Massachusetts Legislature, 1846. Judge of the Court of Common Pleas, 1849–'55. Judge of the State Supreme Court, 1859–'69. Attorney-General of the United States, 1869–'70. Member of the Joint High Commission that framed the Treaty of Washington with Great Britain, 1871. Presidential Elector, 1872. Member of U. S. House of Representatives from Massachusetts, December 1, 1873–March 4, 1875.

GEORGE FRISBIE HOAR.

MASSACHUSETTS.

Regent on behalf of the Senate, February 21, 1881.

Born in Concord, Massachusetts, August 29, 1826. Educated in Concord Academy. A. B., Harvard College, 1846. LL. B., Harvard, 1849. LL. D., William and Mary, 1873; Amherst, 1879; Yale, 1885; and Harvard, 1886. Admitted to the Bar in Worcester, Massachusetts. Member of Massachusetts House of Representatives, 1852; and State Senate, 1857. City Solicitor, 1860. Member of U. S. House of Representatives from Massachusetts, March 4, 1869–March 4, 1877. Member of U. S. Senate from Massachusetts, March 4, 1877–March 3, 1901. President of American Antiquarian Society; American Historical Association, 1895. Member of the Electoral Commission, 1876. Overseer of Harvard College, 1874–'80.

WILLIAM JARVIS HOUGH.

NEW YORK.

Regent on behalf of the House of Representatives, appointed August 10, 1846.

Born in Eaton, Madison County, New York, March 6, 1795; died in Syracuse, New York, October 4, 1869. Admitted to the Bar in Cazenovia, New York. Member of New York Legislature, 1855–'56. Member of U. S. House of Representatives from New York, December 1, 1845–March 3, 1847.

GARDINER GREENE HUBBARD.

CITY OF WASHINGTON.

Regent elected by Congress, February 27, 1895.

Born in Boston, Massachusetts, August 25, 1822. Educated in Boston. A. B., Dartmouth, 1841. LL. D., Columbian, 1888; and Dartmouth, 1893.

Admitted to the Bar in Boston, 1843. Founder of the first school established in United States for teaching the deaf to speak, in Chelmsford, Massachusetts, 1846, afterwards moved to Northampton and incorporated as the Clark School for the Deaf. Member of State Board of Education of Massachusetts for ten years. Special U. S. Commissioner on Railroad Mail Transportation, 1876. Commissioner from Massachusetts to the Centennial Exposition, 1876. President of the Joint Commission of the seven Scientific Societies in Washington, 1895. President National Geographic Society.

JOHN JAMES INGALLS.

KANSAS.

Regent *ex officio*, as President of the Senate *pro tem.*, February 26, 1887–'89.

Born in Middletown, Massachusetts, December 29, 1833. A. B., Williams, 1855. LL. D., Williams, 1884. Admitted to the Bar, 1857. Secretary of Kansas Territorial Council, 1860. Member of the Kansas Senate, 1862. Member of U. S. Senate from Kansas, March 4, 1873–March 3, 1891.

ANDREW JOHNSON.

TENNESSEE.

Regent *ex officio*, as Vice-President of the United States, March 4, 1865.

Born in Raleigh, North Carolina, December 29, 1808; died in Carter County, Tennessee, July 31, 1875. Self-educated. LL. D., Columbia, 1865; and University of North Carolina, 1865. Alderman in Greenville, Tennessee, 1828–'30. Mayor, 1830–'33. Trustee of Rhea Academy, 1831. Member of Tennessee Legislature, 1835, 1839, 1841, and 1843. Presidential Elector for State-at-large, 1840. Member of U. S. House of Representatives from Tennessee, 1843–'53. Governor of Tennessee, 1853–'57. Member of U. S. Senate from Tennessee, December 7, 1857–March 4, '62–March 4, 1875–March 24, 1875. Military Governor of Tennessee, 1862–'64. Vice-President of the United States, 1865. President of the United States, April 14, 1865–March 4, 1869.

JOSEPH EGGLESTON JOHNSTON.

VIRGINIA.

Regent on behalf of the House of Representatives, appointed April 4, 1879.

Born near Farmville, Virginia, February 3, 1807; died in Washington City, March 21, 1891. Graduated United States Military Academy, 1829. Second Lieutenant in Fourth Artillery, 1829. In Black Hawk expedition, 1832. First Lieutenant, Fourth Artillery, 1836. Aide-de-camp to General Scott in the Seminole War. First Lieutenant, Topographical Engineers, 1838. Brevetted Captain for gallantry in the War with the Florida Indians. In charge of many important river and harbor improvements, 1838–'42. Boundary surveys, 1842–'46. Brevetted Major, Lieutenant-Colonel, and Colonel for gallantry in the Mexican War. Quartermaster-General of the Army, 1860–'61. Major-General in Confederate Army, 1861–'65. Member of U. S. House of Representatives from Virginia, March 18, 1879–March 4, 1881. Commissioner of Railroads of the United States, 1887.

WILLIAM PRESTON JOHNSTON.

LOUISIANA.

Regent elected by Congress, January 26, 1892.

Born in Louisville, Kentucky, January 5, 1831. A. B., Yale, 1852. LL. D., Washington and Lee, 1875. Colonel in Confederate Army. Professor of History and English Literature in Washington and Lee University, 1867–'80. President Louisiana State University, 1880. Elected President Tulane University, 1884.

WILLIAM RUFUS KING.

ALABAMA.

Regent *ex officio,* as Vice-President of the United States, March 4, 1853.

Born in Sampson County, North Carolina, April 6, 1786; died in Dallas County, Alabama, April 8, 1853. A. B., University of North Carolina, 1803. Admitted to the Bar in Fayetteville, North Carolina, 1806. Member of North Carolina Legislature. Solicitor of Wilmington District. Member of U. S. House of Representatives from Alabama, December 3, 1810–'16. Secretary of Legation to Naples, 1816. Secretary of Legation to Russia, 1818. Delegate to Convention to Organize State Government for Alabama, 1819. Member of U. S. Senate from Alabama, December 6, 1819–June 17, 1844, December 4, 1848–'53. U. S. Minister to France, 1844–'46. Vice-President of the United States, 1853.

WALTER LENOX.

CITY OF WASHINGTON.

Regent *ex officio,* as Mayor of Washington, June, 1850–June, 1852.

Born in Washington City, August 17, 1817; died in Washington City, July 16, 1874. A. B., Yale, 1837. Member and President of City Council, also an Alderman of Washington. Mayor of Washington City, June, 1850–June, 1852.

HENRY CABOT LODGE.

MASSACHUSETTS.

Regent on behalf of the House of Representatives, appointed January 6, 1890; reappointed January 15, 1892.

Born in Boston, Massachusetts, May 12, 1850. Educated in private school. A. B., Harvard, 1871. LL. B., Harvard, 1874. Ph. D., Harvard, 1876. LL. D., Williams, 1893. Admitted to the Bar in Boston, 1876. University Lecturer on American History, Harvard, 1876–'79. Member of Massachusetts Legislature, 1880–'81. Member of U. S. House of Representatives from Massachusetts, December 5, 1887–March 4, 1893. Member of U. S. Senate from Massachusetts, March 4, 1893–March 3, 1899.

ROBERT McCLELLAND.

MICHIGAN.

Regent on behalf of the House of Representatives, appointed December 22, 1847.

Born in Greencastle, Pennsylvania, August 1, 1807; died in Detroit, Michigan, August 27, 1880. A. B., Dickinson, 1829. Admitted to the Bar in Chambersburg, Pennsylvania, 1831. Member of Michigan Constitutional Convention, 1835. Member of Michigan Legislature and Speaker, 1838–'43. Member of U. S. House of Representatives from Michigan, 1843–'49. Member of Constitutional Conventions of Michigan, 1850 and '67. Governor of Michigan, 1851–'53. Secretary of the Interior, 1853–'57.

GEORGE WASHINGTON McCRARY.

IOWA.

Regent on behalf of the House of Representatives, appointed December 14, 1875.

Born near Evansville, Indiana, August 29, 1835; died in St. Joseph, Missouri, June 23, 1890. Educated in public school and Academy. Admitted to the Bar in Keokuk, Iowa, 1856. Member of the Iowa Legislature, 1857–'65. Member of U. S. House of Representatives from Iowa, March 4, 1869–March 4, 1877. Secretary of War Department, 1877–'79. Judge of United States Circuit Court, 1879–'84.

EDWARD McPHERSON.

PENNSYLVANIA.

Regent on behalf of the House of Representatives, appointed December 19, 1861.

Born in Gettysburg, Pennsylvania, July 31, 1830; died in Gettysburg, Pennsylvania, December 14, 1895. A. B., Pennsylvania College, 1848; and University of Pennsylvania, 1848. A. M., Princeton, 1866. LL. D., University of Pennsylvania, 1877. Admitted to the Bar. Member of U. S. House of Representatives from Pennsylvania, December 5, 1859–March 4, 1863. Deputy Commissioner of Internal Revenue, 1863. Clerk of the House of Representatives, 1863–'73, 1881–'83, 1889–'91. Chief of the Bureau of Engraving and Printing, 1877–'78.

JOHN MACLEAN.

NEW JERSEY.

Regent elected by Congress, January 11, 1868; reëlected January 19, 1874, December 19, 1879, and December 26, 1885.

Born in Princeton, New Jersey, March 3, 1800; died in Princeton, New Jersey, August 10, 1886. A. B., Princeton, 1816. D. D., Washington College, 1841. LL. D., University of the State of New York, 1854. Tutor of Greek in Princeton. Professor of Mathematics and Natural Philosophy in Princeton, 1822–'29. Professor of Ancient Languages, 1829–'47. President of Princeton, 1854–'68.

WILLIAM BEANS MAGRUDER.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, June, 1856–June, 1858.

Born in Baltimore, Maryland, February 11, 1811; died in Georgetown, District of Columbia, May 30, 1869. Studied medicine in Georgetown, District of Columbia. M. D., University of Maryland, 1831. Member of City Councils of Washington twenty years. In charge of Cholera Hospital, 1832. Mayor of Washington City, June, 1856–June, 1858.

GEORGE PERKINS MARSH.

VERMONT.

Regent on behalf of the House of Representatives, appointed December 22, 1847.

Born in Woodstock, Vermont, March 15, 1801; died in Vallambrosa, Italy, July 23, 1882. A. B., Dartmouth, 1820. A. M., Dartmouth, 1860. LL. D., Harvard, 1859; Delaware, 1859; and Dartmouth, 1860. Admitted to the Bar in Burlington, Vermont, 1823. Member of the Vermont Legislature, 1835. Member of Supreme Executive Council of Vermont. Member of U. S. House of Representatives from Vermont, December 7, 1842–March 3, 1849. U. S. Minister to Turkey, 1849–'53. Special U. S. Commissioner to Greece, 1852. U. S. Minister to Italy, 1861–'82. Member of National Academy of Sciences, 1866.

JAMES MURRAY MASON.

VIRGINIA.

Regent on behalf of the Senate, appointed March 6, 1849; reappointed March 6, 1851, and March 6, 1857.

Born in Fairfax County, Virginia, November 3, 1798; died near Alexandria, Virginia, April 28, 1871. A. B., University of Pennsylvania, 1818. Admitted to the Bar in Winchester, Virginia. Member of Virginia Legislature, 1826–'32. Member of the Virginia Constitutional Convention, 1829. Presidential Elector, 1833. Member of U. S. House of Representatives from Virginia, September 4, 1837–March 3, 1839. Member of U. S. Senate from Virginia, December 6, 1847–July 11, 1861.

JOHN WALKER MAURY.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, June, 1852–June, 1854.

Born in Caroline County, Virginia, May 15, 1809; died in Washington City, February 2, 1855. Alderman of Washington City, 1851–'52. Mayor of Washington City, June, 1852–June, 1854. President of the Bank of the Metropolis. Trustee of Columbian University, Washington City.

SAMUEL BELL MAXEY.

TEXAS.

Regent on behalf of the Senate, appointed May 19, 1881.

Born in Tompkinsville, Kentucky, March 30, 1825; died in Eureka Springs, Arkansas, August 16, 1895. Educated in Monroe County, Kentucky. Graduated United States Military Academy, 1846. Brevetted First Lieutenant for gallant conduct in the Mexican War. Admitted to the Bar in Albany, Kentucky, 1850. Elected to Texas State Senate. Brigadier-General, 1862. Major-General of Confederate Army, 1864. Member of U. S. Senate from Texas, March 5, 1875–March 3, 1887.

JAMES MEACHAM.

VERMONT.

Regent on behalf of the House of Representatives, appointed January 2, 1852; reappointed December 14, 1853, and February 26, 1856.

Born in Rutland, Vermont, 1810; died in Middlebury, Vermont, August 22, 1856. A. B., Middlebury, 1832. Tutor in Middlebury. Studied theology. Professor of Elocution and English Literature in Middlebury College. Member of U. S. House of Representatives from Vermont, March 3, 1849–August 22, 1856.

MONTGOMERY CUNNINGHAM MEIGS.

CITY OF WASHINGTON.

Regent elected by Congress, December 26, 1885.

Born in Augusta, Georgia, May 3, 1816; died in Washington City, January 2, 1892. Entered University of Pennsylvania, 1831. Graduated United States Military Academy, 1836. First Lieutenant U. S. Engineers, 1838. Captain, 1853. Corps of Engineers engaged in engineering works, 1841–'50. Colonel of the Eleventh U. S. Infantry, 1861. Quartermaster-General United States Army, 1861. Brigadier-General, 1862. Major-General, 1864. Designed and constructed the Potomac Aqueduct, 1852. Superintended building of the new wings and iron dome of the United States Capitol extension. Built the Captain John Bridge and U. S. Pension Bureau. Member of National Academy of Sciences, 1865.

SAMUEL FREEMAN MILLER.

IOWA.

Regent *ex officio*, as Acting Chief Justice of the United States, March 24, 1888, and Chancellor *pro tem.* pending the appointment of a Chief Justice.

Born in Richmond, Kentucky, April 5, 1816; died in Washington City, October 13, 1890. M. D., Transylvania University, 1837. LL. D., Iowa State University, 1865; Iowa College, 1870; University of Michigan, 1887; and National University, 1890. D. C. L., Georgetown University, 1870. Admitted to the Bar in Kentucky, 1844. Associate Justice of the Supreme Court of the United States, 1862–'90. Member Electoral Commission, 1876–'77.

JUSTIN SMITH MORRILL.

VERMONT.

Regent on behalf of the Senate, appointed February 21, 1883; reappointed March 23, 1885, and December 15, 1891.

Born in Strafford, Vermont, April 14, 1810. Educated in public schools and Academy. A. M., Dartmouth, 1857. LL.D., Vermont University and State Agricultural College, 1874; and University of Pennsylvania, 1884. Member of U. S. House of Representatives from Vermont, December 3, 1855–March 4, 1867. Member of U. S. Senate from Vermont, March 4, 1867–March 3, 1903.

LEVI PARSONS MORTON.

NEW YORK.

Regent *ex officio*, as Vice-President of the United States, March 4, 1889–March 4, 1893.

Born in Shoreham, Vermont, May 16, 1824. Educated in public schools and Academy. LL. D., Dartmouth, 1881; and Middlebury, 1882. Merchant and banker. Honorary U. S. Commissioner to the Paris Exposition, 1878. Member of U. S. House of Representatives from New York, March 18, 1879–March 4, 1881. U. S. Minister to France, 1881–'85. U. S. Commissioner-General to the Paris Electrical Exposition, 1888. Vice-President of the United States, 1889–'93. Governor of the State of New York, 1894–'96.

ROBERT DALE OWEN.

INDIANA.

Regent on behalf of the House of Representatives, appointed August 10, 1846.

Born in Glasgow, Scotland, November 9, 1800; died at Lake George, New York, June 17, 1877. Educated in Berne, Switzerland. LL. D., University of Indiana, 1872. Member of Indiana Legislature, 1835. Member of U. S. House of Representatives from Indiana, December 4, 1843–March 3, 1847. Member and Chairman of Indiana Constitutional Convention, 1850. Member of Indiana Legislature, 1851. Chargé d'Affaires to Naples, 1853. U. S. Minister to Naples, 1855–'58.

PETER PARKER.

CITY OF WASHINGTON.

Regent elected by Congress, January 11, 1868; rëelected January 19, 1874, and December 19, 1879.

Born in Framingham, Massachusetts, June 18, 1804; died in Washington City, January 10, 1888. A. B., Yale, 1831. A. M., Yale, 1858. M. D., Yale, 1834. Studied theology. Went to China as a missionary. Established a hospital in Canton, China. Secretary of United States Embassy and Acting Chargé d'Affaires, China, 1845–'55. Commissioner to China, 1855–'57.

JAMES WILLIS PATTERSON.

NEW HAMPSHIRE.

Regent on behalf of the House of Representatives, appointed December 23, 1863; reappointed December 21, 1865.

Born in Henniker, New Hampshire, July 2, 1823; died in Hanover, New Hampshire, May 4, 1893. A. B., Dartmouth, 1848. LL. D., Iowa College, 1868. Studied theology in Yale. Tutor, 1852–'54; Professor of Mathematics, 1854–'59; Professor of Astronomy and Meteorology, Dartmouth, 1849–'65. Secretary of New Hampshire State Board of Education. Member of the Legislature, 1862–'77, and 1878. Member of U. S. House of Representatives from New Hampshire, December 1, 1862–March 3, 1867. Member of U. S. Senate from New Hampshire, March 4, 1867–March 3, 1873. State Superintendent of Public Instruction in New Hampshire, 1880.

JAMES ALFRED PEARCE.

MARYLAND.

Regent on behalf of the Senate, appointed February 22, 1847; reappointed June 19, 1856, and March 7, 1861.

Born in Alexandria, Virginia, December 14, 1805; died in Charlestown, Maryland, December 20, 1862. A. B., Princeton, 1822. LL. D., Princeton; and St. John's College, 1856. Member of Maryland Legislature, 1831. Admitted to the Bar in Baltimore, 1824. Professor of Law, Washington College, Maryland. Member of U. S. House of Representatives from Maryland, December 7, 1835–March 3, 1843. Member of U. S. Senate from Maryland, January 10, 1843–July 17, 1862. Offered and declined Judgeship of United States District Court of Maryland, and Secretaryship of U. S. Department of the Interior.

ISAAC SAMUALS PENNYBACKER.

VIRGINIA.

Regent on behalf of the Senate, appointed August 10, 1846.

Born in Shenandoah County, Virginia, September 12, 1807; died in Washington City, January 12, 1847. A. B., Washington College. Admitted to the Bar in Harrisonburg, Virginia. Member of U. S. House of Representatives from Virginia, December 5, 1836–July 9, 1838. District Judge, 1839. Declined office of U. S. Attorney-General, and that of Justice of the Supreme Court of Virginia and nomination for Governor. Member of U. S. Senate from Virginia, December 8, 1845–March 3, 1847.

WILLIAM WALTER PHELPS.

NEW JERSEY.

Regent on behalf of the House of Representatives, appointed January 7, 1884; reappointed January 12, 1886, and January 10, 1888.

Born in New York City, August 29, 1839; died in Teaneck, New Jersey, June 17, 1894. A. B., Yale, 1860. A. M., Yale, 1863. LL. D., Rutgers,

1889; and Yale, 1890. LL. B., Columbia, 1863. Admitted to the Bar, 1863. Member of U. S. House of Representatives from New Jersey, December, 1873–March 3, 1875, December 3, 1883–March 4, 1889. U. S. Minister to Austria, 1881. Member of International Conference on the Samoan Question in Berlin, 1889. U. S. Minister to Germany, 1890–'93. Judge of New Jersey Court of Errors and Appeals, 1893–'94.

LUKE POTTER POLAND.

VERMONT.

Regent on behalf of the House of Representatives, appointed March 7, 1867; reappointed February 2, 1870.

Born in Westford, Vermont, November 1, 1815; died in Waterville, Vermont, July 2, 1887. Educated in public schools. A. M., University of Vermont, 1857. LL. D., University of Vermont, 1861. Admitted to the Bar, 1836. Member of State Constitutional Convention, 1843. Prosecuting Attorney for Lamoille County, 1844–'45. Judge of Vermont Supreme Court, 1848–'60. Chief Justice of Vermont, 1860–'65. Member of Legislature, 1878. Member of U. S. Senate from Vermont, December 4, 1865–March 3, 1867. Member of U. S. House of Representatives from Vermont, March 4, 1867–March 4, 1875, December 3, 1883–March 3, 1885.

NOAH PORTER.

CONNECTICUT.

Regent elected by Congress, January 26, 1878; reëlected March 3, 1884.

Born in Farmington, Connecticut, December 14, 1811; died in New Haven, Connecticut, March 4, 1892. A. B., Yale, 1831. A. M., Yale. D. D., University of City of New York, 1858. LL. D., Heidelberg, 1884; Edinburgh, 1886; Western Reserve College, 1870; and Trinity, 1871. Master of Hopkins Grammar School, New Haven, 1831–33. Tutor in Yale, 1833–'35. Pastor of Congregational Churches in Connecticut, 1836–'43, and in Massachusetts, 1843–'46. Professor of Moral Philosophy and Metaphysics in Yale, 1846–'71. President of Yale University, 1871–'86.

WILLIAM CAMPBELL PRESTON.

SOUTH CAROLINA.

Regent elected by Congress, August 10, 1846.

Born in Philadelphia, Pennsylvania, December 27, 1794; died in Columbia, South Carolina, May 22, 1860. A. B., College of South Carolina, 1812. LL. D., Washington and Lee, 1842; and Harvard, 1846. Admitted to the Bar. Studied law in the University of Edinburgh. Member of South Carolina Legislature, 1828–'32. Member of U. S. Senate from South Carolina, 1836. Professor of Belles-lettres and President of College of South Carolina, 1845–'51.

JOHN VAN SCHAICK LANSING PRUYN.

NEW YORK.

Regent on behalf of the House of Representatives, appointed January 7, 1868.

Born in Albany, New York, June 22, 1811; died in Clifton Springs, New York, November 21, 1877. Educated in private schools. Graduated in Albany Academy, 1826. A. M., Rutgers, 1835. LL. D., Union, 1845; and University of Rochester, 1852. Admitted to the Bar, 1832. Member of New York Legislature, 1861. Member of U. S. House of Representatives from New York, December 7, 1863–March 3, 1865, March 4, 1867–March 3, 1869. Regent of University of State of New York, 1844, for thirty-three years, during the last fifteen of which he was Chancellor (1862–'77). President of St. Stephen's College. President of State Commission of Charities. President of the Board of State Survey.

RICHARD RUSH.

PENNSYLVANIA.

Regent elected by Congress, August 10, 1846; reëlected December 24, 1850, and January 28, 1857.

Born in Philadelphia, Pennsylvania, August 29, 1780; died in Philadelphia, Pennsylvania, July 30, 1859. A. M., Princeton, 1797. Admitted to the Bar in Philadelphia, 1800. Attorney-General of Pennsylvania, 1811. Comptroller of the United States Treasury, 1811. Attorney-General of the United States, 1814–'17. U. S. Secretary of State, 1817. U. S. Minister to England, 1817–'25. Secretary of the Treasury, 1825. Commissioner to England to obtain the legacy of James Smithson, 1836–'38. U. S. Minister to France, 1847–'51.

AARON AUGUSTUS SARGENT.

CALIFORNIA.

Regent on behalf of the Senate, appointed January 13, 1874.

Born in Newburyport, Massachusetts, September 28, 1827; died in San Francisco, California, August 14, 1887. Admitted to the Bar, 1854. District Attorney of Nevada County, California, 1856. Member of U. S. House of Representatives from California, July 4, 1861–March 3, 1863, March 3, 1869–March 3, 1873. Member of U. S. Senate from California, March 4, 1873–March 3, 1879. U. S. Minister to Germany, 1882. Declined mission to Russia.

WILLIAM WINSTON SEATON.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, August 10, 1846–June, 1850.

Born in King William County, Virginia, January 11, 1785; died in Washington City, June 16, 1866. Educated in Richmond, Virginia. Mayor of Washington City, June, 1840–June, 1850. Journalist. Editor of the *National Intelligencer*, 1812–'66.

ALEXANDER ROBY SHEPHERD.

CITY OF WASHINGTON.

Regent *ex officio*, as Governor of the District of Columbia, September 13, 1873–June 20, 1874.

Born in Washington City, January 31, 1835. President of Common Council of Washington, 1861. Member of Levy Court of District of Columbia, 1867. Alderman, 1870. Member of Board of Public Works, 1871. Governor of District of Columbia, September 13, 1873–June 20, 1874.

JOHN SHERMAN.

OHIO.

Regent *ex officio*, as President of the Senate *pro tem.*, December 7, 1885–February 26, 1887.

Born in Lancaster, Ohio, May 10, 1823. Educated in public schools, Mount Vernon, and Homer's Academy, Lancaster, Ohio. Admitted to the Bar, Springfield, Ohio, 1844. Member of U. S. House of Representatives from Ohio, December 3, 1855–'61. Member of U. S. Senate from Ohio, March 4, 1861–'77, 1881–'99. Secretary of the Treasury, March, 1877–'81. President of the Senate *pro tem.*, December 7, 1885–February 26, 1887.

WILLIAM TECUMSEH SHERMAN.

CITY OF WASHINGTON.

Regent elected by Congress, January 30, 1871; reëlected March 25, 1878.

Born in Lancaster, Ohio, February 8, 1820; died in New York City, February 14, 1891. Graduated United States Military Academy, 1840. LL. D., Dartmouth, 1866; Yale, 1876; and Princeton, 1878. Served in Indian wars in Florida, in California, etc., 1840–'53. Counsellor-at-Law in Leavenworth, Kansas, 1858–'59. Superintendent of the Louisiana State Military Academy, 1860. Colonel of Thirteenth Infantry, 1861. Brigadier-General, 1861. Major-General, 1862. Lieutenant-General, 1866. General, 1869–'84.

OTHO ROBARDS SINGLETON.

MISSISSIPPI.

Regent on behalf of the House of Representatives, appointed January 7, 1884; reappointed January 12, 1886.

Born in Jessamine County, Kentucky, October 14, 1814; died in Washington City, January 11, 1889. A. B., St. Joseph's College, Kentucky, 1836. Graduated Lexington Law School, 1838. Admitted to the Bar. Member of Mississippi Legislature, 1838–'46. Presidential Elector, 1852. Member of U. S. House of Representatives from Mississippi, December 5, 1853–March 3, 1855, December 1, 1857–March 4, 1861, December 6, 1875–March 4, 1887. Representative in Confederate Congress, 1861–'65.

BENJAMIN STANTON.

OHIO.

Regent on behalf of the House of Representatives, appointed February 26, 1856; reappointed December 14, 1857, and February 21, 1860.

Born near Mount Pleasant, Ohio, June 4, 1809; died in Wheeling, West Virginia, June 2, 1872. Admitted to the Bar in Steubenville, Ohio, 1834. Member of Ohio Senate, 1841–'42. Member of Ohio Constitutional Convention, 1850. Member of U. S. House of Representatives from Ohio, December 1, 1851–March 3, 1861. Lieutenant-Governor of Ohio, 1862–'64.

ALEXANDER HAMILTON STEPHENS.

GEORGIA.

Regent on behalf of the House of Representatives, appointed January 14, 1878.

Born near Crawfordsville, Georgia, February 11, 1812; died in Atlanta, Georgia, March 4, 1883. A. M., Franklin College (now State University), 1832. Admitted to the Bar, 1834. Member of Georgia Legislature, 1836–'43. Member of U. S. House of Representatives from Georgia, December 4, 1843–March 3, 1859, December 1, 1873–March 4, 1881. Vice-President of Confederate States, 1861. Elected Professor of Political Science and History in the University of Georgia, 1868. Governor of Georgia, 1882.

ADLAI EWING STEVENSON.

ILLINOIS.

Regent *ex officio*, as Vice-President of the United States, March 4, 1893–March 4, 1897.

Born in Christian County, Kentucky, October 23, 1835. Educated in Illinois Wesleyan University, and Centre College, Kentucky. Admitted to the Bar, 1857. Master in Chancery, 1861–'65. State Attorney, 1864–'68. Member of U. S. House of Representatives from Illinois, December 6, 1875–March 4, 1877, March 18, 1879–March 4, 1881. First Assistant Postmaster-General, 1885. Vice-President of the United States, March 4, 1893–'97.

JOHN WHITE STEVENSON.

KENTUCKY.

Regent on behalf of the Senate, appointed December 10, 1872.

Born in Richmond, Virginia, May 4, 1812; died in Covington, Kentucky, August 10, 1886. Educated in Richmond. A. B., University of Virginia, 1832. Admitted to the Bar, 1841. Member of the Kentucky Legislature, 1847. Member of State Constitutional Convention, 1849. Member of U. S. House of Representatives from Kentucky, December 1, 1857–March 4, 1861. Lieutenant-Governor, 1867; and Governor of Kentucky, 1867–'71. Member of U. S. Senate from Kentucky, March 4, 1871–March 3, 1877. Professor of Law in Cincinnati Law School, 1877. President of the American Bar Association, 1884. Commissioner to prepare "Code of Practice," 1854. Presidential Elector, 1852, 1856.

DAVID STUART.

MICHIGAN.

Regent on behalf of the House of Representatives, appointed December 14, 1853.

Born in Brooklyn, New York, March 12, 1861; died in Detroit, Michigan, September 12, 1868. Educated in Amherst College, 1842. A. B., Brown. Admitted to the Bar in Detroit, Michigan. Prosecuting Attorney for Wayne County, Michigan. Member of U. S. House of Representatives from Michigan, December 5, 1853–March 3, 1855. Attorney in Chicago. Lieutenant-Colonel of Forty-second Illinois Infantry Volunteers, 1861. Colonel Second Regiment, Douglas Brigade, Fifty-fifth Illinois Infantry, 1861. Brigadier-General of Volunteers, 1862.

ROGER BROOKE TANEY.

MARYLAND.

Regent *ex officio*, as Chief Justice of the United States, August 10, 1846.

Born in Calvert County, Maryland, March 17, 1777; died in Washington City, October 12, 1864. Educated in schools in Maryland. A. B., Dickinson, 1795. LL. D., Dickinson, 1831; and Union, 1835. Admitted to the Bar, Annapolis, Maryland, 1799. Member of Maryland Legislature, 1800–'01. Attorney-General of Maryland, 1827. Attorney-General of the United States, 1831. Secretary of the Treasury, 1833. Chief Justice of the United States, March 15, 1836–October 12, 1864.

EZRA B TAYLOR.

OHIO.

Regent on behalf of the House of Representatives, appointed January 9, 1882.

Born in Nelson, Portage County, Ohio, July 9, 1823. Educated in public schools and academies. Admitted to the Bar, 1845. Prosecuting Attorney, 1854. Removed to Warren, Ohio, 1861. Judge of Court of Common Pleas, 1877. Member of U. S. House of Representatives from Ohio, March 18, 1879–March 4, 1893.

JOSEPH GILBERT TOTTEN.

CITY OF WASHINGTON.

Regent elected by Congress, August 10, 1846; reëlected December 24, 1850, and January 28, 1857.

Born in New Haven, Connecticut, August 23, 1788; died in Washington City, April 22, 1864. A. M., Brown, 1829. Graduated United States Military Academy, 1805. Secretary U. S. Survey of Ohio and the Territories, 1806–'08; Military Engineer, 1808–'64; First Lieutenant, 1810; Captain, 1813; Major, 1818; Lieutenant-Colonel, 1828; Colonel and Chief Engineer U. S. Army, 1838; Inspector U. S. Military Academy, 1838–'64; State Commissioner for preservation of New York and Boston harbors. Served

in Mexican War, 1846. Member of Lighthouse Board, 1851–'58, 1860–'64. Brigadier-General, 1863. Major-General, 1864. Original Member of National Academy of Sciences, 1863.

JOHN THOMAS TOWERS.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington, June, 1854–June, 1856.

Born in Alexandria, Virginia, February 21, 1811; died in Washington City, August 11, 1857. Mayor of Washington City, June, 1854–June, 1856.

LYMAN TRUMBULL.

ILLINOIS.

Regent on behalf of the Senate, appointed December 4, 1861; reappointed March 21, 1867.

Born in Colchester, Connecticut, October 12, 1813; died in Chicago, Illinois, June 25, 1896. LL. D., Shurtleff, 1852; Yale, 1858; and Northwestern, 1870. Principal of Academy in Georgia. Admitted to the Bar, 1837. Illinois Legislature, 1840. Secretary of State of Illinois, 1841–'42. Judge of Supreme Court of Illinois, 1848. Elected Member of U. S. House of Representatives from Illinois, 1854. Member of U. S. Senate from Illinois, March 4, 1855–March 3, 1873.

BENJAMIN FRANKLIN WADE.

OHIO.

Regent *ex officio*, as President of the Senate *pro tem.*, March 2, 1867.

Born near Springfield, Massachusetts, October 27, 1800; died in Jefferson, Ohio, March 2, 1878. Public school education. Admitted to the Bar in Jefferson, Ohio, 1828. Prosecuting Attorney of Ashtabula County, Ohio, 1835–'37. Member of Ohio Legislature, 1837–'41. Presiding Judge of Third Judicial District, Ohio, 1847–'51. Member of U. S. Senate from Ohio, March 4, 1851–March 3, 1869. U. S. Commissioner to Santo Domingo, 1871. President *pro tem.* of the Senate, April, 1865, and March 2, 1867.

MORRISON REMICK WAITE.

OHIO.

Regent *ex officio*, as Chief Justice of the United States, March 7, 1874.

Born in Lyme, Connecticut, November 29, 1816; died in Washington City, March 23, 1888. A. B., Yale, 1837. LL. D., Yale, 1872; Kenyon, 1874; University of Ohio, 1879; and Columbia, 1887. Admitted to the Bar, Maumee City, Ohio, 1839. Member of Ohio Legislature, 1849–'50. Counsel of United States before the Tribunal of Arbitration in Geneva, Switzerland, 1871–'72. President of Ohio Constitutional Convention, 1873. Chief Justice of the United States, March 7, 1874–March 23, 1888.

RICHARD WALLACH.

CITY OF WASHINGTON.

Regent *ex officio*, as Mayor of Washington City, August 26, 1861–June, 1868.

Born in Alexandria, Virginia, April 3, 1816; died in Washington City, March 4, 1881. Educated in Columbian College. Admitted to the Bar in Washington City, 1836. U. S. Marshal for District of Columbia, 1849–'53. Member of Common Council, 1848–'49. Mayor of Washington City, August 26, 1861–June, 1868. Under his administration the first fine public-school buildings in the city were erected.

HIRAM WARNER.

GEORGIA.

Regent on behalf of the House of Representatives, appointed February 26, 1856.

Born in Hampshire County, Massachusetts, October 29, 1802; died in Atlanta, Georgia, 1881. Admitted to the Bar in Knoxville, Georgia, 1825. Member of Georgia Legislature, 1828–'31. Judge of Superior Court of Georgia, 1833–'40. Judge of Supreme Court of Georgia, 1845–'53. Member of U. S. House of Representatives from Georgia, December 3, 1855–March 3, 1857. Judge of the Supreme Court of Georgia and Chief Justice, 1872.

JAMES CLARKE WELLING.

CITY OF WASHINGTON.

Regent elected by Congress, May 13, 1884; reëlected May 22, 1890.

Born in Trenton, New Jersey, July 14, 1825; died in Hartford, Connecticut, September 4, 1894. A. B., Princeton, 1844. LL. D., Columbian University, 1868. Studied Law. Associate Principal of New York Collegiate School, 1848. Literary editor of the *National Intelligencer* in Washington, 1850–'56; its Chief Editor and Manager, 1856–'65. Clerk of United States Court of Claims, 1865–'67. President of St. John's College, Maryland, 1867. Professor of Belles-lettres in Princeton, 1870–'71. President of Columbian University, 1871–'94. President of Board of Trustees of Corcoran Art Gallery, 1877–'94.

JOSEPH WHEELER.

ALABAMA.

Regent on behalf of the House of Representatives, appointed January 10, 1888; reappointed January 6, 1890, January 15, 1892, January 4, 1894, and December 20, 1895.

Born in Augusta, Georgia, September 10, 1836. Graduated United States Military Academy, 1859. Lieutenant United States Cavalry, 1860–'61. Colonel, Brigadier-General, and Lieutenant-General in Confederate Army, and Senior Cavalry General, 1861–'65. Admitted to the Bar, 1866. Member of U. S. House of Representatives from Alabama, March 4, 1881–March 3, 1883, March 4, 1885–March 4, 1899.

WILLIAM ALMON WHEELER.

NEW YORK.

Regent *ex officio*, as Vice-President of the United States, March 4, 1877–March 4, 1881.

Born in Malone, New York, June 30, 1819; died in Malone, New York, June 4, 1887. A. B., University of Vermont, 1842. A. M., Dartmouth, 1865. LL. D., University of Vermont, 1867; and Union, 1877. Admitted to the Bar in Malone, New York, 1845. U. S. District Attorney of Franklin County, New York, 1845–'49. Member of New York Legislature, 1849–'50. Member and President *pro tem.* of New York Senate, 1858–'59. Member of U. S. House of Representatives from New York, December 3, 1860–July 17, 1862, March 4, 1869–March 3, 1877. President of New York Constitutional Convention, 1867–'68. Vice-President of the United States, March 4, 1877 March 4, 1881.

ANDREW DICKSON WHITE.

NEW YORK.

Regent elected by Congress, February 15, 1888; reëlected March 19, 1894.

Born in Homer, New York, November 7, 1832. Educated in Hobart College, New York. A. B., Yale, 1853. A. M., Yale, 1856. Ph. D., Jena, 1889. LL. D., University of Michigan, 1867; Cornell, 1886; and Yale, 1888. L. H. D., Columbia, 1887. Professor of History and English Literature in University of Michigan, 1857–'62. Member of New York Senate, 1863–'64. President of Cornell University, 1867, 1881–'85. U. S. Commissioner to Santo Domingo, 1871. U. S. Minister to Germany, 1879–'81. U. S. Honorary Commissioner to Paris Exposition, 1878. U. S. Minister to Russia, 1892–'95. Member of U. S. Venezuelan Commission, 1896. First President of American Historical Association, 1884.

HENRY WILSON.

MASSACHUSETTS.

Regent *ex officio*, as Vice-President of the United States, March 4, 1873–March 4, 1877.

Born in Farmington, New Hampshire, February 16, 1812; died in Washington City, November 22, 1875. A. M., Williams, 1860. LL. D., Dartmouth, 1874. Member of Massachusetts Legislature, 1840–'43, 1850. President of Massachusetts Senate, 1851–'52. Member of State Constitutional Convention, 1853. Member of U. S. Senate from Massachusetts, February 10, 1855–March 3, 1873. Vice-President of the United States, 1873–'75.

WILLIAM LYNE WILSON.

WEST VIRGINIA.

Regent on behalf of the House of Representatives, appointed January 7, 1884; reappointed January 12, 1886. Regent elected by Congress, January 14, 1896.

Born in Jefferson County, Virginia, May 3, 1843. Educated in Charlestown Academy. A. B., Columbian, 1860. LL. D., Columbian, 1883;

Hampden-Sidney, 1886, and University of Mississippi; Tulane; and Central College, Missouri, 1895. Professor of Latin, Columbian College, 1865–'71. Admitted to the Bar, 1871. President of West Virginia University, 1882. Member of U. S. House of Representatives from West Virginia, March 4, 1883–March 4, 1895. Presidential Elector, 1880. Postmaster-General, 1895–'97.

ROBERT ENOCH WITHERS.

VIRGINIA.

Regent on behalf of the Senate, appointed March 1, 1877.

Born in Campbell County, Virginia, September 18, 1821. M. D., University of Virginia, 1840. Practised medicine, 1840–'58. Major and Colonel in Confederate Army, 1861. Lieutenant-Governor of Virginia, January 1, 1874. Member of U. S. Senate from Virginia, March 4, 1875–March 3, 1881.

THEODORE DWIGHT WOOLSEY.

CONNECTICUT.

Regent elected by Congress, April 2, 1862; reëlected January 11, 1868.

Born in New York City, October 31, 1801; died in New Haven, Connecticut, July 1, 1889. A. B., Yale, 1820. D. D., Harvard, 1847. LL. D., Wesleyan, 1845; and Harvard, 1886. Studied law in Philadelphia, 1821; Theology in Princeton, 1821–'23. Tutor in Yale, 1823–'25. Licensed to preach, 1825. Professor of Greek Languages and Literature in Yale, 1831–46. President of Yale University, 1846–71.

THE THREE SECRETARIES

BY GEORGE BROWN GOODE

JOSEPH HENRY

I.

THE early history of American science is very closely connected with the life of Professor Henry. Born with the present century, he participated in the early movements for the national organization of science. In his later years he was an acknowledged leader in the work of maintaining and extending these, in accordance with the tendencies of modern thought.

Between 1827—when he entered the little company of American investigators, at that time few in number, and for the most part young and inexperienced—and 1878, when he died, a recognized leader of a numerous and well-organized army of trained men, there intervened a full half century, and one which was of great significance in the history of the Western continents, since it was peculiarly a formative period for all those interests upon which the moral and intellectual welfare of our people depends.

For two decades he lived in the laboratory and the lecture-room, and at the end of that period he was accepted as one of the world's great investigators, distinguished alike for skill and originality in experiment and for breadth and philosophic comprehensiveness in deduction. Three other decades of his life were given to the organization and development of the scientific and educational interests of the nation.

It is impossible to estimate the extent of the influence of those fifty years of intense, devoted toil, of constant, painstaking effort, all directed toward one consistent end. Few men have combined so fully the characteristics of the scholar, the teacher, the organizer, and leader; and few have been so placed that their capacities in such widely different fields of activity could be constantly employed.

Henry's success as an administrator was unquestionably due to the versatility of his talents and to the catholicity of his sympathies, which forbade favoritism toward individual interests or men. His lofty character and self-sacrificing devotion were so manifest in his face and in his actions that all were impressed by them, and thereby rendered incapable of opposition. Rivalry and enmity never entered into his relations to those with whom he worked. The noblest and best of his associates were always valued and devoted friends, and there were few of the greatest of his countrymen, whether statesmen, divines, or men of letters, who were not proud to say that they knew him well and loved him.

The organization of the Smithsonian Institution was the task to which his later years were devoted. This will always be regarded, by the few who appreciate the necessities and difficulties of scientific administration, as his most important achievement. There can be no doubt that he himself so regarded it, since he felt justified in practically abandoning the career of an investigator at the time when it was full of the

most brilliant promise, notwithstanding the protests of many who considered it a waste of high talent for him to give up his own investigations for the sake of providing opportunities for the work of others.

The story of his administration will be found interwoven with that of the Institution in every chapter of this book. In this place attention will be directed chiefly to his contributions to science and to his personal traits and interests.

II.

JOSEPH HENRY was born in Albany, December 17, 1799. His father was William Henry, his mother was Annie Alexander. His grandparents on both sides, the Henrys and the Alexanders, came in the same ship from Scotland to the colony of New York on June 17, 1775, landing while the first guns of the American Revolution were sounding.

During early childhood he lived in Albany, and from the age of seven to thirteen near the country village of Galway, in the adjoining county of Saratoga.

He was seemingly an idle boy, whose mind was full of romance, and whose time was chiefly occupied in the reading of novels, poetry, and Shakspere. His young life was full of dreams, and the efforts of his relatives to induce him to give attention to practical matters were for a time fruitless. He was apprenticed to a watchmaker; but, notwithstanding his natural taste for mechanism, the occupation was uncongenial, and was soon abandoned. For the time the theater was more to his taste. When in Albany[1] visiting his rela-

[1] There was from 1813 to 1816 an excellent theater in Albany under the management of Mr. John Bernard, one of the best of the English comedians, author of "Retrospectus of the Stage" and "Retrospectus of America, 1797–1811." In his company were Samuel Drake, Henry Placide, Norah M. Ludlow, and Frances Ann Denney (Mrs. Drake), all of whom were noted in the history of the American stage. See Sol Smith's "Theatrical Apprenticeship," which was published in Philadelphia in 1845.

tives this was his chief interest. He became an amateur actor, organized a juvenile theatrical company, "The Rostrum," and translated a play from the French, which his young friends acted under his direction. Thus, perhaps, were laid the foundations of subsequent success as a public speaker and presiding officer.

His taste for books was first aroused by Sir Henry Brooke's "Fool of Quality," which he chanced to open when a boy of eight or ten. This philosophical romance aroused his interest in social problems, and led him through the pathway of fiction to form the habit of reading.

President Porter has pointed out the intimate relationship between this early aimless life and his later career:

"His early musings and questionings, his boyish sports and adventures, were fondly remembered by him as the inspiration of his rational and scientific life. 'The cultivation of the imagination,' he writes, 'should be considered an essential part of a liberal education; and this may be spread over the whole course of instruction, for, like the reasoning faculties, the imagination may continue to improve until late in life.' 'Memory, imitation, imagination, and the faculty of forming mental habits exist in early life, while the judgment and reasoning faculties are of slow growth.' 'The order of nature is that of art before science, the entire concrete first and the entire abstract last.' These are wise and weighty words, but they are of special interest when we bethink ourselves that the writer, when he penned them, was doubtless all the while thinking of a dreaming boy, half buried in the grass, looking up wistfully into the sky, thinking wondrous thoughts too deep for tears, perhaps peopling with phantoms and fairies that world of nature which he subsequently penetrated by those wise questionings and ingenious theories which his sagacious experiments turned into solid verities. He certainly could have been thinking of no one else when in the same connection he so positively affirms, 'The future

character of a child, and that of a man also, is in most cases formed probably before the age of seven years.' "

It was not until 1815 that he discovered the real tendency of his mind toward scholarship, through the instrumentality of a work entitled "Lectures on Experimental Philosophy, Astronomy, and Chemistry, intended chiefly for the Use of Young Persons," published in London, in 1809, by the Reverend George Gregory, D.D., editor of the "New Annual Register." The book, which the chance of fortune placed in his hands, is still preserved by his family, and upon one of its blank leaves, written by the hand of Henry, are the following words:

"This book, although by no means a profound work, has, under Providence, exerted a remarkable influence on my life. It accidentally fell into my hands when I was about sixteen years old, and was the first book I ever read with attention. It opened to me a new world of thought and enjoyment; invested things before almost unnoticed with the highest interest; fixed my mind on the study of nature, and caused me to resolve at the time of reading it that I would immediately commence to devote my life to the acquisition of knowledge. J. H."

The purpose of his life having been determined, his future might easily have been predicted by any one familiar with his peculiar mental and physical endowments. An iron constitution, capable of fatigueless effort for sixteen hours or more each day, year in and year out, and an indomitable will, even more powerful in control of self than in that of others, together with a mind clear and original, shaped by many generations of ancestors living in the rural simplicity of old Scotland; a pleasing presence, and an attractive personality, were his heritage. The community in which he lived was

intelligent and liberal, and all gates were open to a young man of integrity and enterprise.

He now entered upon serious work — first as a pupil in a night school; then in the Albany Academy, as scholar and teacher; later as a medical student, a private tutor, and a surveyor. At the age of twenty-six he was appointed Professor of Mathematics in the Albany Academy, and his scientific life was fairly begun.

His famous paper in Silliman's "American Journal of Science," printed in January, 1831, demonstrated his right to a place among advanced investigators in the field of electro-magnetism, and led to his election, in 1832, to the professorship of Natural Philosophy in the College of New Jersey, where he remained for fourteen years. Of his life at Princeton Professor Asa Gray has written:

"Here he taught and investigated for fourteen fruitful and happy years; here he professed the faith that was in him, entering into the communion of the Presbyterian Church, in which he and his ancestors were nurtured; and here he developed a genius for education. One could count on his being a clear expositor, and his gifts for experimental illustration and for devising apparatus had been already shown. But now, as a college professor, the question, how to educate, came before him in a broader way. He appreciated, and he made his associates and pupils appreciate, the excellence of natural philosophy for mental discipline, for training at once both the observing and the reasoning faculties. A science which rises from the observation of the most familiar facts, and the questioning of these by experiment, to the consideration of causes, the ascertaining of laws, and to the most recondite conceptions respecting the constitution of matter and the interplay of forces, offers discipline to all the intellectual powers, and tasks the highest of them. Professor Henry taught not only the elementary facts and general principles from a fresh survey of both, but also the methods of philo-

sophical investigation, and the steps by which the widest generalizations and the seemingly intangible conceptions of the higher physics have been securely reached. He exercised his pupils in deducing particular results from admitted laws, and in then ascertaining whether what was thus deduced actually occurred in nature; and if not, why not. Though very few of a college class might ever afterward undertake a physical or chemical investigation, all would, or should, be concerned in the acquisition of truth and its relations; and by knowing how truth was won and knowledge advanced in one field of inquiry, they would gain the aptitude which any real investigation may give, and the confidence that springs from a clear view and a sure grasp of any one subject.

"He understood, as few do, the importance of analogy and hypothesis in science. Premising that hypothesis should always be founded on real analogies and used interrogatively, he commended it as the prerequisite to experiment, and the instrument by which, in the hands of sound philosophers, most discoveries have been made. This free use of hypothesis as the servant and *avant-courier* of research — as means rather than end — is a notable characteristic of Henry."

In 1830 he married his cousin Miss Harriet L. Alexander, who on the death of her father, Alexander Alexander, an active and successful business man of Schenectady, had come to live in Albany. It was largely through Henry's influence that her elder brother, Stephen Alexander, was called to Princeton in 1833, where he subsequently became professor of astronomy. Mrs. Henry survived her husband but a few years, and died in Washington City on March 25, 1882.

The memory of Henry is lovingly cherished at Princeton, where a bronze tablet by Augustus St. Gaudens was erected in 1885, to commemorate his connection with the University.[1]

[1] The memorial address delivered by Edward N. Dickerson, LL. D., upon the occasion of the presentation of this tablet, is one of the most eloquent and satisfactory appreciations of the character and achievements of Professor Henry.

III.

Henry's experimental work was done, for the most part, between 1826 and 1847. Many of his broader generalizations were published later, though these were largely based upon the work of early years.

His studies in electricity began in 1827, while he was a teacher in the Albany Academy, and it was not long before Sir David Brewster was moved to say: "On the shoulders of young Henry has fallen the mantle of Franklin!" His laboratory work in Albany included the only continuous series of physical investigations which any one had up to that time attempted in America.

In the course of these researches he transformed an inefficient piece of electrical apparatus — the significance of which had been but partially understood by Ampère, Arago, and even Sturgeon, by whom it had been greatly improved — into the powerful electro-magnet, and laid the foundation for the most important discoveries of the century, — not only his own, but those of the great masters of Europe. The electro-magnet in 1828 was still an ineffective instrument. Barlow had tested its capabilities in London three years before, and had found its effect so diminished at the distance of only two hundred feet that he pronounced telegraphy by its use impossible.

In Henry's hands the feeble toy of Sturgeon was converted into instruments of infinite possibilities. He made two distinct forms of magnets, one capable of excitation at a distance, which he named the "intensity magnet"; another having possibilities of infinite development of strength, to which he gave the name of "quantity magnet."

He so named the magnets because he had discovered that with the one, in order to overcome the resistance opposed to the passage of electricity by the long, fine wire of which it

was composed and the long circuit in which it was placed, it was necessary to use an "intensity battery,"—that is, a battery of many plates—for the reason that this battery possesses more electromotive force; while with the other, formed of many coils of short, thick wire, offering less resistance, a "battery of quantity" should be employed. "I was the first," he wrote, "to point out this connection of the two kinds of battery with the two forms of the magnet in my paper in Silliman's Journal, January, 1831, and clearly to state that when magnetism was to be developed by means of a compound battery, one long coil was to be employed, and when the maximum effect was to be produced by a single battery a number of single strands were to be used."

The importance of this discovery of the necessary law of proportion between the electromotive force in the battery and the resistance in the magnet cannot be too highly estimated; not only does the telegraph depend upon this law, but every action of galvano-magnetism.

As has well been said by his daughter, "he married the intensity magnet to the intensity battery, the quantity magnet to the quantity battery, discovered the law by which their union was effected, and rendered their divorce forever impossible." The intensity magnet is that which is to-day in use in every telegraph system.

With the discovery of these two agents began a new epoch in science and in the arts. They brought the force of electricity, hitherto only in part subdued, fully under the control of man. Before Henry, the only electro-magnet which had been made, though under the influence of a battery of 125 plates, was incapable of lifting more than nine pounds; but he, after a few months of experiment, produced one which, with one pair of plates, sustained 39 pounds, or fifty times its own weight; in 1830, 750; in 1831, 2300; and in 1834, 3500

pounds. These improvements rendered possible not only his own subsequent discoveries, but also those of Faraday, which began first to assume importance after the invention of Henry's magnets.

The quantity magnet perfected by Henry in 1830 was the means by which both he and Faraday discovered magneto-electricity. It has been used in almost all electrical work, scientific or practical, which has since been attempted. Sturgeon wrote in 1832: "Henry has been enabled to produce a magnetic force which completely eclipses every other in the whole annals of magnetism; and no parallel is to be found since the miraculous suspension of the celebrated Oriental impostor in his iron coffin."[1]

"The importance of this discovery," wrote Professor William B. Taylor of the intensity magnet, "can hardly be overestimated. The magnetic 'spool' of fine wire—of a length tens and even hundreds of times that ever before employed for this purpose—was in itself a gift to science, which really forms an epoch in the history of electro-magnetism. It is not too much to say that almost every advancement which has been made in this fruitful branch of physics since the time of Sturgeon's happy improvement, from the earliest researches of Faraday downward, has been directly indebted to Henry's magnets. By means of the Henry 'spool' the magnet almost at a bound was developed from a feeble childhood to a vigorous manhood. And so rapidly and generally was the new form introduced abroad among experimenters, few of whom had ever seen the papers of Henry, that probably very few indeed have been aware to whom they were really indebted for this familiar and powerful instrumentality. But the historic fact remains, that prior to Henry's experiments in 1829, no one on either hemisphere had ever thought of winding the limbs of an electro-magnet on the principle of the 'bobbin,' and not till after the publication of Henry's method in January of 1831, was it ever employed by any European physicist.

[1] *Philosophical Magazine*, London, March, 1832, Volume XI, page 199.

"But in addition to this large gift to science, Henry (as we have seen) has the preëminent claim to popular gratitude of having first practically worked out the differing functions of two entirely different kinds of electro-magnet: the one surrounded with numerous coils of no great length, designated by him the 'quantity' magnet, the other surrounded with a continuous coil of very great length, designated by him the 'intensity' magnet. The latter and feebler system (requiring for its action a battery of numerous elements,) was shown to have the singular capability (never before suspected or imagined) of subtle excitation from a distant source. Here for the first time is experimentally established the important principle that there must be a proportion between the aggregate internal resistance of the battery and the whole external resistance of the conjunctive wire or conducting circuit. This was a very important though unconscious experimental confirmation of the mathematical theory of Ohm, embodied in his formula expressing the relation between electric flow and electric resistance, which, though propounded two or three years previously, failed for a long time to attract any attention from the scientific world.

"Never should it be forgotten that he who exalted the 'quantity' magnet of Sturgeon from a power of twenty pounds to a power of twenty hundred pounds, was the absolute CREATOR of the 'intensity' magnet; and that the principles involved in this creation, constitute the indispensable basis of every form of the electro-magnetic telegraph since invented."[1]

The first labor in which this infant giant was employed was to demonstrate the practicability of the telegraph. By its aid Henry was enabled in 1829 or 1830 to pass a current through a wire 1060 feet in length and to lift at its end a considerable weight.

"This was the first discovery of the fact that a galvanic current could be transmitted to a great distance with so little diminution of force as to produce mechanical effects." So said Henry in 1857, critically reviewing the progress of elec-

[1] Taylor, William B. "Memorial of Joseph Henry," page 226.

trical science during the period of nearly thirty years which had elapsed since this early experiment was made.[1]

To strike signals upon a bell at the distance of 8000 feet was a result accomplished in the same year in the commencement hall of the Albany Academy. The importance of this experiment in connection with the history of the telegraph is discussed at greater length elsewhere.

All these experiments were made in the autumn and early winter of 1829 or 1830, as seems to be very clearly shown by Miss Mary A. Henry in her recent essays.[2] The fixing of these dates is of considerable moment, since upon them depend the dates of two other discoveries, that of self-induction and that of magneto-electricity.

The former, that of the so-called "extra current," made August, 1829 or 1830, though it was not announced until 1832,[3] is now conceded to him by all[4] and it was chiefly in recognition of the discovery of self-induction that his name was given to the standard UNIT OF INDUCTIVE RESISTANCE at the International Congress of Electricians in Chicago, in August, 1893, thus bestowing upon him, as Mendenhall expresses it, "the high honor of a place in the galaxy of famous physicists whose names shall be perpetuated in the metrological nomenclature of all languages." At this congress, composed of twenty-six representative men of science, from nine great nations, Professor von Helmholtz presided.

"It was gratifying to the American delegates in the Chamber at Chicago," writes Mendenhall,[5] "that the motion

1 "Smithsonian Report," 1857, page 110.

2 Henry, Mary A., "America's Part in the Discovery of Magneto-Electricity — A Study of the Work of Faraday and Henry." I–V. *The Electrical Engineer*, 1892, Volume XIII, page 27 *et seq.* "The Electro-Magnet; or Joseph Henry's Place in the History of the Electro-Magnetic Telegraph," I–XII; *ibid.*, XVII, 1894, page 1 *et seq.*

3 *American Journal of Science*, 1832, Volume XXII, page 403.

4 This was, in 1834, rediscovered by Faraday, who did not until some time after perceive the relation of his work to that which had preceded.

5 Mendenhall, T. C., "The Henry," *Atlantic Monthly*, Volume LXXIII, pages 613–614, No. 439, May, 1894.

to adopt 'henry' as the name of this unit came from Professor Mascart, the distinguished leader of the French delegation, for among the French, some years ago, another name, the 'quadrant' or 'quad' had been proposed, and since that time much used; that it was seconded by one of the leading delegates from England, Professor Ayrton, who had himself, a few years ago, proposed the word 'sec-ohm,' as being a proper name for the unit of induction, a proposition which for a time found much favor; and finally, that it received the unanimous approval of the entire Chamber, thus furnishing a testimonial of the highest order of the estimation in which the work of Joseph Henry is held, and a recognition of his rank as a natural philosopher which some of his own countrymen have been somewhat tardy to appreciate and acknowledge."

The discovery of magneto-electric induction in 1830 followed that of the extra or self-inductive current, which, for that matter, Henry always maintained should be considered to be identical with magneto-electricity,[1] and in connection with which he, first of all men, obtained electrical manifestations from a magnet.

"An electric current," writes Kennelly, "was in 1819 found [by Oersted] to have magnetic properties. Here in 1830 the converse relation was first noticed, [by Henry] that a conductor in motion through magnetized space developed electrical properties. The propositions in these terms did not receive full proof or recognition for some years, but Henry seems to have been the first to observe an electrical current induced by a magnet."[2]

Faraday made the same discovery in 1831 with the aid of Henry's two forms of magnets, and was the first to print the

[1] *The Electrical Engineer*, March 9, 1892, Volume XVII, page 249.

[2] Kennelly, A. E., in chapter on "Typical American Inventions," in "The United States of America," edited by N. S. Shaler, New York, 1894, Volume II, page 143.

results of his observations.[1] Since discovery without announcement cannot claim a place in history, except as a matter of biographical incident, this discovery is generally accredited to him. It is proper that this should be so, and Henry himself was too generous a man ever publicly to claim any honor in this connection. He often, however, mentioned to his friends the fact that he had anticipated Faraday by nearly a year.[2]

It is even pathetic to read the words of praise which he somewhere printed concerning Faraday, speaking of him as "the discoverer of magneto-electricity, which had made his name immortal."

It surely cannot be unjust to the memory of Faraday that Henry should stand in the records of science as an original and independent discoverer of magneto-electricity, nor just to Henry, not to state the fact, that, although anticipated in publication, he was actually the first.

While in Albany he constructed the electro-magnetic engine, which will be referred to later, and also, as his daughter has shown, began the construction of an instrument corresponding to the modern dynamo.[3]

After his removal to Princeton, he carried on many re-

[1] It was by the same means that Faraday subsequently investigated the phenomena of magnetism, and the effect of magnetic action upon polarized light. See Franklin L. Pope, *Journal of the American Electrical Society*, 1879, Volume II, page 126.

[2] George W. Carpenter, his associate and assistant in Albany, in 1826–32, writes: "In a well remembered conversation with me he alluded to an incident in his own experience. After retiring one night, he worked out mentally how he could probably draw a spark from the magnet. Upon rising in the morning he hurried to his working room, arranged the apparatus, tried the experiment, when success crowned his labor. He had accomplished what had never been done before. Unfortunately he failed to publish his discovery. In continuing his remarks, he added that Faraday, some time after, successfully tried the same experiment, and at once announced it, before Professor Henry's success was publicly known."

The Reverend Doctor Cuyler, one of his earliest pupils in Princeton, said he often spoke to him of his disappointment about that discovery. "I ought to have published earlier," he used to say. "I ought to have published, but I had so little time. I desired to get out my results in good form, and how could I know that another on the other side of the Atlantic was busy with the same thing?"

[3] *The Electrical Engineer*, Volume XIII, pages 54, 251.

searches, all of which are described in Doctor Taylor's well-known discourse.[1] There he prosecuted his later studies upon induction. He developed his apparatus for the combination of circuits, the principle of which underlies the various forms and uses of the relay magnet, and the receiving magnet and local battery, since employed in the telegraph. He carried on his classical investigations upon successive orders of induction.[2] He found that a second induced current could induce a third, and the third a fourth, and so on indefinitely; that a current of intensity could produce one of quantity, and the converse; and that these currents could be induced at a distance. He obtained an induced current in one room from a primary current in the next room. From two wires stretched perpendicularly several hundred feet apart, and finally connecting the tin roof of his house with his study, he magnetized needles by induction from a thundercloud eight miles away.

The discovery of the oscillatory character of the discharge from the Leyden jar — one of his most important contributions to science — followed in 1842. He ascertained that in the discharge of a jar an equilibrium is not instantaneously effected by the spark, but is attained only after several oscillations of the flow; a fact which was not only in itself significant, but led to important advances in theory.[3] As Doctor Oliver Lodge has shown, the explanations offered by him in connection with these early experiments were almost prophetic of the great generalizations subsequently made by Clerk Maxwell and others, but which in the state of electrical

1 Taylor, William B., "The Scientific Work of Joseph Henry." *Bulletin of the Philosophical Society of Washington*, 1878, Volume II, page 230. "Memorial of Joseph Henry," 1880, pages 205–425.

2 *Transactions American Philosophical Society*, 1838, Volume VI, page 303.

3 See Barker, George F., "Physics," New York, 1892, page 613; Lodge, Oliver J., "Modern Views of Electricity," London, 1889, page 369; Taylor, W. B., "Memorial of Joseph Henry," page 255; Houston, Edwin J., "Electricity a Hundred Years Ago and To-day," New York, 1894, page 61.

science at that day it was impossible that any finite mind should have reached.

In addition to his brilliant contributions to electrical science, he carried on studies in many other departments of physics. Those in meteorology were very extensive. His experiments upon the effect of the discharge of lightning from the clouds, and upon the condition of lightning-rods while transmitting discharges of electricity, were perhaps the most conspicuous of these. In molecular physics his attention was given to capillary absorption and the cohesion of liquids, as well as to a discussion of the atomic hypothesis of Newton.

He made investigations on certain phenomena connected with light and heat. By his experiments on the phosphorogenic ray of the sun, he first demonstrated that it is polarizable and refrangible by the laws which govern light. In connection with Professor Alexander, he carried on a series of experiments on the relative heat-radiating power of the sun-spots. He reflected heat from concave mirrors of ice, and from his experiments drew conclusions as to the source of the heat derived from the moon. He constructed a thermal-telescope, composed of a common pasteboard tube, covered with gilt paper and blackened internally, with which he measured the heat of distant objects: with this he could detect the heat of a man's face a mile off, and that of a house five miles off; and with it ascertained that the coldest spot of the sky is at the zenith. He also invented the method now generally employed for determining by the use of electricity the velocity of the flight of projectiles.

Not only in ingenious experiment and the interpretation of its results, not only in the practical application of Nature's laws, but still more in his philosophical comprehension of Nature was manifested the greatness of Henry. The English physicist Fleming, in a recent work, writes:

"At the head of this long line of illustrious investigators stand the preëminent names of Faraday and Henry. On the foundation-stones of truth laid down by them all subsequent builders have been content to rest. The 'Experimental Researches' of the one have been the guide of the experimentalist no less than the instructor of the student, since their orderly and detailed statement, alike of triumphant discovery and of suggestive failure, make them independent of any commentator. The 'Scientific Writings' of Henry deserve hardly less careful study, for in them we have not only the lucid explanations of the discoverer, but the suggestions and ideas of a most profound and inventive mind, and which indicate that Henry had early touched levels of discovery only just recently becoming fully worked."

Such praise as this is excellent evidence of the influence of Henry's discoveries upon the marvelous progress of electricity during the past five or ten years, and what Fleming has written concerning electricity is equally true of his work in many other branches of science.

IV.

THE relation of Henry to the beginnings of the telegraph have been for half a century the subject of much discussion and of controversies in which, during his lifetime, he steadfastly refused to participate. In 1857, however, statements were made concerning some of his acts which he felt it his duty to bring to the attention of the Board of Regents, by whom his relation to the whole matter was carefully investigated. The testimony presented by himself and others at this time is of the greatest interest and importance.

It is not my purpose to make far-reaching claims for him, yet a biographical sketch would be incomplete which should

make no reference to the facts upon which such claims have been founded by others.

His own position in regard to these matters should not be misunderstood. He was professedly a discoverer, and not an "inventor." He said: "My ambition is to add to the sum of human knowledge by the discovery of new truths which may be of some use to the world. The practical application of these I leave to others." When asked why he had not patented his application of the electro-magnet to the telegraph, he only replied, simply: "I thought it unbecoming the dignity of true science to curtail the use of discovery to personal and selfish uses; on the contrary, I thought it right to give it to the world as a means of advancing humanity."

His testimony on behalf of the defendant in the Supreme Court case of Morse vs. O'Reilly, in 1849, is convincing evidence of his magnanimity, for he made no allusion to his own experiment in Albany in which long-distance telegraphic signals had been made. "Had he done so," writes Pope, "and had others then living and familiar with the circumstances been brought forward to corroborate his statement, the result would inevitably have proved fatal to Morse's claim to the process of producing sound-signals at a distance by electro-magnetism, and would virtually have thrown the whole invention open to the public, a result which Henry could not but have foreseen."

Before Henry's magnets, and his discoveries in relation to them, had been made, the modern telegraph was still an impossibility. It is true that when he began his work the idea of an electro-telegraph was nearly a century old. Morrison, of Greenock, Scotland, had as early as 1753 suggested a practical mode of transmitting messages by frictional electricity, and galvanic and chemical telegraphs had been in use from the time of Salva of Barcelona to that of the first projects of

Davy and Morse. The modern, or electro-magnetic, telegraph was not proposed, however, until 1820, after the revival by Oersted of the knowledge of the power of the galvanic current to deflect a suspended magnetic needle.

The "needle-telegraph," that in which intelligence is transmitted by the motion of the galvanoscopic indicator, was the form to which the attention of European theorists and investigators was now directed. Ampère, before 1823, had worked out the theory of a telegraph with several needles. The first operative system of this type was that devised in 1828 by Triboaillet, who employed a single wire and a galvanoscopic indicator. Schilling exhibited in Russia in 1832 a single-circuit instrument with thirty-six needles. This was improved and used in experimental work at a distance of 9000 feet in Göttingen, in 1833, by Gauss and Weber, who utilized the discoveries of Henry and Faraday.[1] The needle-indicator used by these investigators was essentially the same as that still occasionally employed, especially in connection with long submarine cables.

The other form of telegraph is that in which sounds and permanent signs are made by the attraction of an electro-magnet. It was this system which Henry devised and used in a simple form, and this which Morse and his staff, acting avowedly under the advice of Henry, were first to develop into a practical agency for the transmission of words. Henry was the first, as already remarked, to demonstrate the fact that a galvanic current could be transmitted to a great distance with so little diminution of force as to produce mechanical effects adequate to telegraphic uses. He actually constructed, and operated in Albany, as early as 1830, the first electro-magnetic machine for producing at will sounds that could be heard at a distance, and published at

[1] Gray, Thomas, "Proceedings and Addresses, Patent Centennial Celebrations," page 181.

this time a statement that the improvements made by him were "directly applicable to the project of forming an electro-magnetic telegraph."[1]

In other words, he was the first to construct and use an electro-magnetic acoustic telegraph of a type similar to that which is at present more generally employed than any other form. The code of signals now in general use was yet to be invented. Provided with such a code, any operator could, by the use of Henry's apparatus, have transmitted, in 1831, messages of unlimited length, though of course at slow speed.[2]

Before Henry made his magnets, and his discoveries in relation to them, the telegraph was an impossibility, for until then science was not ripe for the telegraph. Henry's intensity magnet was the only electro-magnet which had ever responded to electrical influence at any distance. Before it was created there could be no electro-magnetic telegraph. Equally essential was his discovery of the law by which magnet and battery were bound together in mutual proportion.

Henry was also the first to use the earth for a return circuit, although the credit for this is usually given to Steinheil. This practice was in some degree foreshadowed by Watson and Franklin, both of whom used water to conduct a return current. Watson in this manner lighted alcohol on the further side of a pond; Franklin, across the river Schuylkill. Watson passed a current through the earth; Franklin immediately showed by experiment that this was due to the constant moisture of the earth. It was Henry, however, who first practically used the earth for a return current. It is true that

[3] *American Journal of Science*, January, 1831, Volume XIX, page 404.

[2] The introduction of the second voltaic battery rendered possible results in respect to speed not at that time within the range of human achievements. All that was needed to perfect Henry's invention into a recording telegraph was the invention of the steel style in the extremity of the sounding lever, and a grooved roller into which it could strike the paper as it was drawn onward over the roller to emboss upon it the alphabetical characters. (F. O. J. Smith, letter to the Regents of the Smithsonian Institution, March 30, 1872.)

in his testimony before the Supreme Court in 1849, he, with characteristic modesty, alluded to Steinheil as a discoverer of this use of the earth.[1] In 1876, however, with the fuller knowledge which he then possessed, he wrote to Reverend S. B. Dod in Princeton:

"I think the first actual line of telegraph, using the earth as a conductor, was made in the beginning of 1836. A wire was extended across the front campus of the college grounds, [in Princeton] from the upper story of the library building to the philosophical hall on the opposite side, the ends terminating in two wells. Through this wire, signals were sent, from time to time, from my house to my laboratory."[2]

Another step was his device, used in Princeton as early as 1833, of opening one circuit by means of another. By this he was able to carry out his plan of utilizing the power of a quantity magnet at great distances, through the agency of the more sensitive intensity magnet. Of the utmost importance has this combination proved to the telegraph—its principle underlying all the various forms and uses of the relay magnet and the receiving magnet and local battery since employed.[3]

"One morning," writes Professor Trowbridge, "he came into my laboratory at Cambridge, and, after I had shown him various pieces of scientific apparatus, he stood before an electro-magnet which was working a relay and looked long at the magnet, and then at the battery which was coupled for quantity, and remarked in a quiet tone, as if half to himself, 'If I had patented that arrangement of magnet and battery I should have reaped great pecuniary reward for my discovery of the practical method of telegraphy.'"

1 "Smithsonian Report," 1857, page 113.

2 "Memorial of Joseph Henry," 1880, page 150.

3 A circuit-breaker made and used by Henry in Princeton is now in the United States National Museum.

Sir Charles Wheatstone, who, with his associate, Sir William Fothergill Cooke, developed the system of Schilling after it left the hands of Gauss and Weber, was the first to bring the telegraph into practical commercial use; and although his plan, involving as it did the employment of a number of separate line wires and needle-indicators, was soon abandoned on account of its expense and perplexity, it is still the popular belief in England that Wheatstone was the inventor of the electric telegraph. The reason for this is, in part, that he was the first in England to secure patents for the telegraph; and, in part also, that he at one time claimed to have been the discoverer of the intensity magnet. There is, nevertheless, good reason to believe that Wheatstone was directly indebted to Henry for the information which enabled him to utilize the intensity magnet in connection with his telegraph. He was engaged in his experiments when visited by Henry and Bache at King's College, in April, 1837, and his apparatus was examined and his plans discussed by them. He had already found the electro-magnet inefficient as a sound-signal, and was endeavoring to introduce a secondary circuit as a remedy for the diminution of force encountered in the long circuit. Henry has recorded that he then explained to Wheatstone a different method of bringing the second galvanic circuit into action, and it was Henry's method which Wheatstone employed in his final successes.[1]

"It is evident," writes Mr. Fahie, an English expert, "that it was not until *after* the interview with Henry that Wheatstone recognized the applicability of Ohm's law to telegraphic circuits."[2] Mr. Fahie, however, ignores the fact that it was Henry's discovery, and not Ohm's formula, which was

[1] Cooke records that on many occasions in March and April the efforts of Wheatstone and himself to excite magnetism at long distances were unsuccessful.

[2] Fahie, J. J., "A History of Electric Telegraphy to the Year 1837," London, 1884, page 515.

adopted by Wheatstone, for Ohm's law was at that time unknown in England, as well as in America.

Although Wheatstone in his controversy with Cooke, in 1841, claimed as his own the discovery that electro-magnets may be so constructed as to produce the required effects by means of a direct current, even in very long circuits, he subsequently, in 1856, referring to the same early experiments, wrote: "With this law and its applications, no persons *in England* who had before, occupied themselves with experiments relating to electric telegraphs, had been acquainted."[1] This can only be interpreted as an admission of Henry's priority.[2] There was never, it is true, an acknowledgment from Wheatstone of his indebtedness to Henry for advice which enabled him to perfect his experiment in 1837; but, as has been pointed out, it is a very significant fact that in March, 1837, the magnet was discarded by Wheatstone; in April his interview with Henry took place, and in April the magnet was again employed and the success of the English telegraph secured.

The following summary is quoted from a well-known English authority:

"It was only by Henry's discoveries that the electro-magnetic telegraph of Morse became possible, and Morse himself, before he became involved in patent ligitation, freely acknowledged his indebtedness to Henry. But Professor Henry, long before Morse's telegraph came before the world, had suggested the application of his electro-magnets to telegraphy, and had even constructed a form of bell-telegraph for experimental purposes which answered remarkably well. Henry, however, had for his object 'the advancement of science,

[1] Cooke, William Fothergill, "The Electric Telegraph: Was it Invented by Professor Wheatstone?" Part II, London, 1857, page 57. A series of controversial papers between Cooke and Wheatstone.

[2] *The Electrical Engineer*, January 13, 1892, Volume XIII, page 30 (footnote); Pope, Franklin Leonard, "Life and Work of Joseph Henry," 1879, *Journal of the American Electrical Society*, Volume II, page 134.

without any special or immediate reference to its application to the wants of life or useful purposes in the arts.' He sought no patents for inventions, and solicited no remuneration for his labors, other than credit for having done what it was in him to do for the promotion of scientific knowledge. He gave freely to the world the results of his researches, and others devoted themselves to the practical applications of the principles which he discovered. Of these were not only Morse in America, but Wheatstone and Cooke in this country. It has been amply demonstrated that these inventors were at a standstill in the early part of 1837 for the want of a means of producing a strong effect at the receiving station. Although Henry had clearly shown the advantage of employing closely wound coils of fine wire in 1831, Wheatstone knew nothing apparently of this, and remained in ignorance until April, 1837, when he was enlightened by Professor Henry himself. We are firmly convinced that Henry did more for the advancement of the telegraph than has ever yet been adequately acknowledged."[1]

Another practical outgrowth of his early investigations in connection with which his name has less frequently been mentioned, because perhaps there has been less controversy in regard to its history, was the production of mechanical power by electro-magnetism.

Henry in 1829 constructed the first electro-magnetic motor, an oscillating machine with automatic pole-changer. This he described in 1831.[2] In 1833 Sturgeon constructed the first rotary motor, which he exhibited to the learned men in London, giving to Henry credit for priority in construction of electro-magnetic engines.

The English electrician Joule writes:

"It is to the ingenious American philosopher that we are indebted for the first form of the working model of an engine

[1] *Electrical Review*, London, August 12, 1887, Volume XXI, page 162.
[2] *American Journal of Science*, 1831, Volume XX, page 340.

upon the principle of reciprocating polarity of soft iron by electro-dynamic agency."[1]

Henry's oscillating machine was the forerunner of all our modern electrical motors. The rotary motor of to-day is the direct outgrowth of his improvement in magnets.

It should also be stated that he had as early as 1832, or before, applied one of his great magnets to the separation of magnetic iron from other substances, and in 1833 this system, which has since become one of great industrial importance, was put into actual use at the Penfield Iron-Works, in the village of Port Henry, named at that time in honor of the Albany professor.

Thomas Davenport, a blacksmith from Salisbury, Vermont, who visited the Port Henry iron-works about this time, bought one of the magnets and used it in the experiments which led not only to the construction by him of the earliest operating rotary motors, but which within two years led[2] to the beginning of the electric railroad; for he exhibited in 1835, in Springfield, Troy, and Philadelphia, not only rotary motors in action, but a model engine carrying its own magnet, which ran around upon a circular track.

Even more significant than the invention of this engine was Henry's philosophic and far-reaching appreciation of what it meant for the future. "So far from giving way to the natural enthusiasm of the successful inventor," writes Pope, "Henry proceeded, with calm sobriety of judgment, to forecast the future possibilities of the new motor. He was soon led to see that under the conditions of knowledge then existing, the power could only be derived from the oxidation of zinc in a galvanic battery, and hence the heat energy re-

[1] Joule, James P., "Historical Sketch of the Rise and Progress of Electro-magnetic Engines for Propelling Machinery."

[2] "Notes on the Electric Railway: Historical, Statistical, and Technical." A paper read before the New York Electric Club, January 22, 1891, by Franklin Leonard Pope. See *The Electrical Engineer*, January 28, 1891.

quired in the original smelting of the metal must represent at least an equal amount of power. Hence his conclusion that the fuel required for that purpose might with better advantage be employed directly in performing the required work.

"While feeling thus sure that electricity could not hope to compete with, much less to supersede, steam as a primary source of power, Henry, nevertheless, did not hesitate to predict that the electric motor was destined in the future to occupy an extensive field of usefulness, particularly in applications in which absolute theoretical economy was subordinate to more important considerations.

"Time has shown that Henry's conception of the legitimate field of the electric motor was prophetically accurate." [1]

V.

WITH the organization of the Smithsonian Institution in 1846 came an entire change in Henry's life. Many years before, while he was still a teacher in Albany, Smithson had died in Genoa, leaving his bequest "for the increase and diffusion of knowledge among men." When Henry first visited Europe, in 1837, the bequest had only just become known, and the claim of the United States was in course of prosecution in London. To this circumstance may, perhaps, be attributed the interest which he seemed always to have felt in the disposition of the Smithson fund. In the fall of 1846, after the Regents of the new Institution had been appointed, a committee of their own number was chosen to digest a plan to carry out the provisions of the Act to establish the Smithsonian Institution. Henry's advice was sought by them, and the plan proposed by him was embodied in the report which they presented to the Board on the first of December. It

[1] The *Electrical Engineer*, London, February 13, 1891, Volume VII, page 169.

was with a knowledge of this fact that, at their meeting of December 3, he was elected to the Secretaryship, after the following resolutions had been passed:

"*Resolved*, That it is essential, for the advancement of the proper interests of the trust, that the Secretary of the Smithsonian Institution be a man possessing weight of character, and a high grade of talent; and that it is further desirable that he possess eminent scientific and general acquirements; that he be a man capable of advancing science and promoting letters by original research and effort, well qualified to act as a respected channel of communication between the Institution and scientific and literary individuals and societies in this and foreign countries; and, in a word, a man worthy to represent before the world of science and of letters the institution over which this Board presides."

"It does not need to be said," writes Doctor Welling, "that Professor Henry did not seek this appointment. It came to him unsolicited, but it came to him from the Board of Regents, not only by the free choice of its members, but also at the suggestion and with the approval of European men of science like Sir David Brewster, Faraday, and Arago, as also of American scientific men like Bache and Silliman and Hare. I well remember to have heard the late George M. Dallas (a member of the constituent Board of Regents by virtue of his office as Vice-President of the United States) make the remark on a public occasion, immediately after the election of Professor Henry as Director of the Smithsonian Institution, that the Board had not had the slightest hesitation in tendering the appointment to him 'as being peerless among the recognized heads of American science.'"

He accepted the election on December 7, and on the 21st appeared at a meeting of the Board of Regents and entered upon the duties of his office. The first duty imposed

upon him by the Board was the preparation of a program of organization, which was presented on December 8, 1847, and in its essential features adopted on the 13th. By this "Plan of Organization" and the brief essay in which it was explained and illustrated, the future character of the Institution was determined. It was shown that the Institution is not a national establishment in the sense in which institutions dependent on the government are so, and that its operations ought to be mingled as little as possible with those of the government, and its funds applied exclusively and faithfully to the diffusion of knowledge among men; that the bequest is intended for the benefit of mankind in general, and that its influence ought not to be restricted to a single district or even nation; that the terms "increase" and "diffusion" of knowledge are logically distinct, and should be literally interpreted with reference to the will; that the increase of knowledge should be effected by the encouragement of original researches of the highest character and its diffusion by the publication of the results of original research, by means of the publication of a series of volumes of original memoirs; that the operations of the Institution should not be restricted in favor of any particular kind of knowledge, though if preference is to be given to any branches of research, they should be to the higher and apparently more abstract, to the discovery of new principles rather than of isolated facts.

These were, in brief, the principles announced in this masterly treatise.

In the second part of the program propositions were made in regard to the promotion of certain interests prescribed in the plan adopted by Congress: the accumulation and care of collections of objects of nature and art, the development of a library, the providing of courses of lectures, and the organization of a national system of meteorological observation.

It was from the beginning Henry's belief that expenditures from the Smithson fund for objects such as those last mentioned were not justifiable, and that museums, libraries, and lectures, being in one sense local objects, should be supported from the revenues of the government. Still more strenuously was he opposed to the erection of an expensive building, and by painstaking economy during his long period of office he succeeded in restoring to the fund the amount which, in his opinion, had been improperly invested in stone and mortar. He never ceased to urge upon the Regents and upon Congress the impropriety of burdening the legacy of the founder with expenditures which he deemed in large degree local, either to the City of Washington or to the United States, and to urge that "the bequest was intended for the benefit of man in general." As the result of this policy he had the satisfaction, before his death, of seeing the library, which soon became great and cumbersome, received and cared for at government expense in connection with the Library of Congress; the meteorological service transformed into a permanent weather bureau and transferred to the War Department; the National Museum supported by direct appropriations, and the system of international exchanges in large part maintained by government grants; while the resources of the Institution were left comparatively free, to be used for the increase and diffusion of knowledge for the benefit of the entire world.

Concerning the details of his administrative work, more cannot be said than that in the routine of each day he employed the same conscientious methods and the same powers of mind which he had been accustomed to use in his investigation of the laws of nature. But for the man, the devotion with which he worked, and the fact that his life was spared to labor for the Institution for nearly a third of a century, it is

not impossible that the uncanny predictions of John Quincy Adams as to the fate of the Smithsonian bequest might have been fulfilled.

It was much for the Institution to have secured as an organizer a man of such commanding abilities, of such wide and lofty aims, and one whose character was noble beyond the possibility of any tarnish. It was much, on the other hand, for Henry to abandon the life of an investigator, at the very time when the promise of the future was so brilliant. He was fully conscious of his own great powers and that he was sacrificing, as he expressed it, "future fame to present reputation." He understood, however, the opportunities for good which the new position would afford, and, with a full appreciation of what he was doing, cheerfully sacrificed his own scientific career to what he knew would be for all time a powerful aid to the work of investigators without number. By this act he did much toward establishing the profession of scientific administration — a profession which in the complexity of modern civilization is becoming more and more essential to scientific progress. That he himself appreciated this fact is clearly shown in his loving eulogy of his friend Alexander Dallas Bache; and yet it is not impossible that he was mistaken in supposing that this change of activities had lessened the chance of future fame. For so long as the Smithsonian Institution endures, the name of its first Secretary will be remembered with it.

VI.

After his election to the Secretaryship, Professor Henry, although by a special resolution of the Board of Regents, January 26, 1847, "requested to continue his researches in physics, and to present such facts and principles as may be

developed for publication in the 'Smithsonian Contributions,'" did not find it consistent with his duties, as he understood them, to take time necessary for any continuous laboratory work in connection with the labors of organizing and shaping the character of the new foundation.

His annual reports, which were models of full and exact administrative treatment, were always written by himself, and abounded in critical and philosophical remarks bearing not only upon the work of the Institution, but also upon the significance of the work in which it was engaged, and its relations to the scientific questions of the day. During the first ten years his papers were but few. At the meeting of the American Association in 1850, he remarked, at the conclusion of a brief conversation, that for the last three and a half years all his time and all his thought had been given to the details of the business of the Smithsonian Institution; he had been obliged to withdraw himself entirely from scientific research; but he hoped, now the Institution had been gotten under way, and the Regents had allowed him some able assistants, that he would be enabled, in part at least, to return to his first love — the investigation of the phenomena of nature.

His anticipations were not, however, to be realized in the manner hoped for. His subsequent work in science was for the most part that which grew out of his official connections, and his published papers such as embodied trains of thought suggested by the administrative work which he was directing. His studies upon direct and reflected sound grew out of his experiments to remedy the defects of a Smithsonian hall intended for public speaking. His generalizations in regard to the primary powers in connection with which he expressed his views on the correlation of physical and organic forces, were developed in an address upon "The Improvement of

the Mechanical Arts," delivered at an exhibition of the Washington Mechanics' Institute. His classical "Thoughts on Education" were delivered by him on the occasion of his retirement from the presidency of the Association for the Advancement of Education. Out of the wealth of his observations and reflections in connection with the Smithsonian meteorological work was developed his memoir upon "Meteorology in Connection with Agriculture," which was published in the reports of the Commissioner of Agriculture for five successive years, 1855 to 1859. This forms a volume of four hundred pages, by far the most extensive of his published writings, which is still a standard work of reference among students of this science. There was, indeed, no subject in which he took a keener interest than meteorology, and to his practical methods was due the daily weather map, essentially in its present form. How early this interest began is shown by the following extracts from his note-books, hitherto unprinted.

Under date of February 9, 1849, occurs the following entry:

"I have had in my mind a fine scheme with the telegraph. Instantaneous observations, on the Aurora, on the thunder-storm, the beginning of storms, etc., etc."

Also, under date of March 12, the following:

"Mr. Redfield highly approves plan of using telegraph for meteorological purposes. The following places should be made stations: Portland, Boston, New York, Philadelphia, Baltimore, Washington, Norfolk, Charleston, Savannah, Mobile, Pensacola, Augusta, Nashville, New Orleans (northern and southern).

"Galena, St. Louis, Chicago, Buffalo, Albany, Boston (western).

"Times—morning, noon, and night, or morning and night. Most important observations: 1. Barometer. 2. Face of the sky. 3. Direction and force of the wind. The rise of the barometer will precede a fall."

Under May 19, is the following entry:

"Wrote to Judge McLean to give me an account of his obs. on thunderstorms. Thunder storms come from the west at Washington—on the opposite side of the river divide, one part down, the other to Baltimore. Prepare circulars relative to storms of this kind."

The "Instructions for Meteorological Observers" were written by his own hand. The instruments for distribution were tested by him, and that magnificent corps of observers whose contributions, covering a period of thirty years, constitute a considerable portion of the foundation of meteorological science, was kept together by his personal labor in correspondence.

His original study was not limited, however, to electricity or to physics. He entered every field into which human thought may enter.

He was, perhaps, the first to work out a theory of the correlation of physical, chemical, and vital forces. This was in 1844. His conclusions were essentially as follows:[1]

"They who are disposed to continue the speculation . . . may extend the generalization so as to reduce all mechanical motion on the surface of the earth to a source from without. Thus . . . the mechanical power exerted by animals is due to the passage of organized matter in the body from an unstable to a stable equilibrium [or, as it were,] (from the combus-

[1] *Proceedings of the American Philosophical Society*, 1844, Volume IV, page 127; *American Journal of Science*, 1845, Volume XLVIII, page 215; *The London, Edinburgh, and Dublin Philosophical Magazine*, 1845, Volume XXVI, page 541.

tion of fuel).[1] It would therefore appear to follow that animal power is referable to the same sources as that from the combustion of fuels [namely, the decomposing energy of the sun's rays]. . . . Vitality is that mysterious principle which propagates a form and arranges the atoms of organizable matter, while the power with which it operates, is derived from the divellent power of the sunbeam."[2]

Later, in 1857, his theory was more fully elaborated, and even then long antedated Doctor William B. Carpenter's better known essay, "On the Application of the Principle of the Conservation of Force to Physiology," 1884, in which much of the same ground was gone over as if for the first time, the author being evidently in ignorance of Henry's previous paper. Others had, however, been at work between 1844 and 1857, and it was to this fact that Professor Lovering alluded when he said:

"In this connection Henry's views on the correlation of the physical and organic forces may be recalled, which only lacked the fuller development and wider publication which he finally gave to them to have secured for him the first complete announcement of one of the grandest generalizations of modern science."[3]

The latest and most comprehensive generalization in physics — that which culminated in the researches of Hertz — seems also in a certain way to have been foreseen by Joseph Henry, much as those of Joule were foreseen by Lord Bacon and by Thompson.

"Faraday's immortal researches, Clerk Maxwell's prophetic investigations, and Hertz's convincing experiments,"

[1] This condensation is Henry's own, and is contained in Professor Taylor's "Memorial of Joseph Henry," page 273.

[2] "Scientific Writings of Joseph Henry," Volume 1, page 222.

[3] "Memorial of Joseph Henry," page 438.

writes Preece, "have definitely and conclusively proved the existence of one medium throughout all space, called the ether, through which waves of energy, called radiations, are propagated with the same velocity, but in different forms and with different frequencies, although all of the same character. At one end of the scale we have actinic disturbances producing photographic impressions; at the other end of the scale electric waves producing electro-magnetic disturbances, while the intermediate radiations give light and heat."[1]

Compare now the summary of present opinions just quoted, omitting only the words within the brackets (which I have myself added), with what Henry wrote nearly half a century before:

"We cannot avoid the conclusion [that] all the phenomena of the imponderables result from the different actions of one all-pervading principle. . . . An iron rod, rapidly hammered, becomes red hot, or, in other words, emits heat and light. The same rod, insulated by a non-conductor, exhibits electrical attraction and repulsion. Again, if this rod be struck with a hammer while in a vertical position, it becomes magnetic. We have here the evolution of the four classes of phenomena by a simple agitation of the atoms. We cannot, in accordance with the known simplicity of the operations of nature, for a moment imagine that these different results are to be referred to as many different and independent principles."[2]

So far as theory goes, it would seem that Clerk Maxwell's proposition in 1865, that light is an electro-magnetic disturbance, was simply a variation of the previous proposition of Henry, and that Henry's utterance was an indication of the deep insight into the inevitable future course of experimental research in this direction. The facts brought out by Max-

[1] "Electric Signalling without Wires," *Journal of the Society of Arts*, Volume XLII, pages 274, 275, February 23, 1894.

[2] *Proceedings of the American Association for the Advancement of Science*, 1851, Volume VI, pages 84–91.

well, taken in connection with the experiments of Hertz, have demonstrated that optics is a department of electricity.

"To produce radiation," comments Barker, "it is necessary only to produce electric oscillations of sufficiently short period. An atom of sodium vibrates five hundred million times in one millionth of a second. Could we produce electric atomic oscillations at this rate and permanently maintain them we could produce light. The problem of the age is, how to convert some other form of energy into the energy of light. That this is possible in theory, Rayleigh long ago showed. That it is actually accomplished in nature, Langley's remarkable measurements upon the glow-worm abundantly confirm."[1]

Another evidence of the penetration, as well as the independence of his thought is shown by the fact that he was among the earliest of American men of science to approve the theory of evolution, as announced by Darwin. In 1864 he wrote to Asa Gray, who soon after the publication of the "Origin of the Species" had become one of the warmest and most influential of its authorized champions, in these words:

"I have given the subject of evolution much thought, and have come to the conclusion that it is the best working hypothesis which you naturalists have got. It, in fact, gives you the first basis or real scientific foundation to stand upon which you have ever had."

Doctor Gray was at that time in the midst of a vigorous controversy upon this subject with many of the principal American naturalists, the most uncompromising of whom was Agassiz. Although Henry's views were not made public, it was generally understood that he sympathized with Darwin and Gray. Agassiz, at that time a Regent of the Institution, earnestly remonstrated with him and urged that he should

[1] Barker, George F., "Physics," New York, 1892, page 873.

take no stand for or against the theory; and his remonstrances were supported by those of a number of his friends in Washington, members of the church which he was accustomed to attend, who were greatly disturbed that he should entertain opinions which seemed so heterodox and dangerous. His attitude was never shaken, however, although he never felt called upon to express his views publicly. "I am a physicist, and not a naturalist," said he, "and it is not proper for me to participate in this discussion; but if there is any science in natural history, this is the first step which has ever been taken to demonstrate it."

Much of his most careful work was in connection with economic problems submitted to him individually, or as a member of various commissions, by the government of the United States. In 1851 he was actively concerned in the modes of testing building materials, in connection with the examination of marble for the extension of the United States Capitol. In 1855 he used the great tower of the Institution building for experiments to test a new process for procuring alcohol, for which a patent had been granted.

In 1852, when the Lighthouse Board of the United States was organized, President Fillmore appointed him one of its members; and on this Board he served until his death, and from 1871 to 1877 was its chairman. He thus had opportunity to make his famous researches on sound in relation to fog-signaling, in connection with which grew up his discussion of the subject with Professor Tyndall. These researches were of the highest scientific value, and at the same time led to immediate practical results of the greatest importance. He also conducted the experiments on illuminants which resulted in a complete revolution in the methods of lighthouses, replacing sperm-oil by lard-oil in 1866, which substitution, competent authorities estimated in 1877, had already saved to the

government not less than one million dollars. To these experiments he gave much attention, devoting to them the time of his summer holiday for many years. It is generally conceded that the high efficiency of our national lighthouse system is largely due to his labors.

During the Civil War he was, together with Professor Bache and Admiral Davis, the member of a commission to examine and report upon various investigations and experiments intended to facilitate the operations of war and to improve the art of navigation. Many of the experiments were conducted at the Institution. From the top of the great tower, night after night, lights were flashed to distant stations, in connection with tests of methods of signaling; and many a time Professor Henry's companion in these studies was President Lincoln, glad to leave the scene of turmoil in which his days were passed and to seek rest and inspiration in the quiet companionship of such a man as Henry.

Out of the labors of this commission grew the National Academy of Sciences, established in 1863 by act of Congress, to advance science and to report upon such questions of scientific character as might be connected with the operations of the government. Bache was its first president, and Henry succeeded him, holding that place until his death.

VII.

It has already been shown that his original investigations during his thirty years at the Smithsonian Institution were not of great extent; but his influence, not only upon the development of scientific work in the United States, but upon its character, cannot be overestimated. His official position brought him into constant contact, either personally or by letter, with all in the United States who were engaged in

scientific work, and the inspiration and the direct control which he exercised were constant and far-reaching. The cordial hospitality of his home in Washington was never forgotten by any to whom it was given, and all who came to it received a hearty welcome. He lived, from 1855 until his death, in the east wing of the Smithsonian building. His wife, whom as Miss Harriet L. Alexander he married in 1830, and his three daughters, aided him to make it one of the centers in the intellectual life of Washington, and there were few distinguished visitors to the city who did not enter his doors.

Many remember his presence at the meetings of the American Association for the Advancement of Science, and the impression made by his brief addresses, often simply a few words of greeting, not even reported in the proceedings. In his later years, in 1871, the Philosophical Society of Washington was organized, and he was its president as long as he lived. The meetings, occurring every two weeks through the winter, were events in Washington, and were attended not only by students of science, but by many of the greatest of our public men, while visiting men of science who made communications were not few. Here, for the first time, was announced the discovery of the telephone. The discussions were often remarkable for their brilliancy and weight, and the society in those days, unaffected by the withdrawal of specialists to form organizations devoted to particular branches, was a very remarkable one. The spirit of Henry dominated the whole, and his stately presence as he presided and his impressive remarks when, as not infrequently happened, he participated in the discussions, made every meeting memorable. His address on the organization of a scientific society, at the time of its foundation, presents the highest ideal of what a local scientific society should be. And the height of his ideals for science and for men of science is shown by his

closing address to the National Academy of Sciences, a few days before his death:

"Whatever might have been thought as to the success of the Academy, when first proposed by the late Professor Louis Agassiz, the present meeting conclusively proves that it has become a power of great efficiency in the promotion of science in this country. To sustain this effect however much caution is required to maintain the purity of its character and the propriety of its decisions.

"For this purpose great care must be exercised in the selection of its members. It must not be forgotten for a moment that the basis of selection is actual scientific labor in the way of original research, (that is in making positive additions to the sum of human knowledge,) connected with unimpeachable moral character.

"It is not social position, popularity, extended authorship, or success as an instructor in science, which entitles to membership, but actual new discoveries; nor are these sufficient if the reputation of the candidate is in the slightest degree tainted with injustice or want of truth. Indeed, I think that immorality and great mental power actually exercised in the discovery of scientific truths are incompatible with each other, and that more error is introduced from defect in moral sense than from want of intellectual capacity."

A few days before his death, unable to pursue his customary routine of work, his mind became more than usually concerned upon the mystery of existence and the meaning of human life; and at this time, without the knowledge of his family, he wrote to his friend Mr. Patterson a letter, in which he recorded the results of his lifelong thoughts upon this subject:

"After all our speculations," he wrote, "an attempt to grapple with the problem of the universe, the simplest conception which explains and connects the phenomena is that

of the existence of one Spiritual Being—infinite in wisdom, in power, and all divine perfections, which exists always and everywhere—which has created us with intellectual faculties sufficient, in some degree, to comprehend His operations as they are developed in Nature by what is called 'Science.'

"This Being is unchangeable, and, therefore, His operations are always in accordance with the same laws, the conditions being the same. Events that happened a thousand years ago will happen again a thousand years to come, provided the condition of existence is the same. Indeed, a universe not governed by law would be a universe without the evidence of an intellectual director.

"In the scientific explanation of physical phenomena, we assume the existence of a principle having properties sufficient to produce the effects which we observe; and when the principle so assumed explains, by logical deductions from it, all the phenomena, we call it a theory. Thus, we have the theory of light, the theory of electricity, etc. There is no proof, however, of the truth of these theories, except the explanation of the phenomena which they are invented to account for.

"This proof, however, is sufficient in any case in which every fact is fully explained, and can be predicted when the conditions are known. In accordance with this scientific view, on what evidence does the existence of a Creator rest?

"*First.* It is one of the truths best established by experience in my own mind, that I have a thinking, willing *principle* within me, capable of intellectual activity and of moral feeling.

"*Second.* It is equally clear to me that you have a similar spiritual principle within yourself, since when I ask you an intelligent question you give me an intellectual answer.

"*Third.* When I examine the operations of Nature, I find everywhere through them evidences of intellectual arrangement, of contrivances to reach definite ends, precisely as I find in the operations of man; and hence I infer that these two classes of operations are results of similar intelligence.

"Again, in my own mind, I find ideas of right and wrong, of good and evil. These ideas, then, exist in the universe, and, therefore, form a basis of our ideas of a moral universe. Furthermore, the conceptions of good which are found among our ideas associated with evil, can be attributed only to a Being of infinite perfections, like that which we denominate 'God.' On the other hand, we are conscious of having such evil thoughts and tendencies that we cannot associate ourselves with a Divine Being, who is the Director and Governor of all, or even call upon Him for mercy, without the intercession of One who may affiliate himself with us."

Notwithstanding his sacrifice of investigation to administration, there is no greater name in American science. What Franklin was to the last century, Henry is to this, and as the years go by his fame is growing brighter. The memorial service in his honor, held in 1878, in the hall of the United States House of Representatives, was a national event. In 1883 his monument in bronze, by the greatest of American sculptors, was erected by Congress in the Smithsonian Park. The bestowal of his name upon the unit of induction in 1893 was an indication of his foreign appreciation, while, as a still nobler tribute to his fame, his statue has been placed under the great rotunda of the National Library, the science of the world and of all time being symbolized by these two great men, NEWTON and HENRY.

SPENCER FULLERTON BAIRD

I.

NO name occupies a more honorable place in the annals of American science than that of Professor Baird. His personal contributions to systematic biology were of great extent. His influence in inspiring and training men to enter the field of natural history was very potent. As an organizer, working at a most fortunate time, he knew how to utilize his extraordinary opportunities, and he has left his impress forever fixed upon the scientific and educational institutions of the United States, more especially upon those under government control.

He was one of those rare men, perhaps more frequently met with in the New World than elsewhere, who give the impression of being able to succeed in whatever they undertake. Although he chose to be a naturalist, and of necessity became an administrator, no one who knew him could doubt that he would have been equally eminent as a lawyer, physician, mechanic, historian, business man, soldier, or statesman.

II.

It is always interesting to search for the sources of intellectual force and capacity, especially so in this country, where the races of the Old World have mingled with such rapidity and in such volume as to develop very remarkable phases in the problem of heredity.

For an inquiry of this kind there is excellent material in the case of Professor Baird, for though he gave little atten-

tion to such matters in his later busy life, there is still in e
istence an elaborate "genealogical tree," prepared by himse
at the age of sixteen, by the aid of which it has been pract
cable to identify his ancestors up to and including all those
the fifth degree, thirty in number, and in many lines far beyon

His grandparents were all the children of colonial Pennsy
vanians. He was emphatically an American, for over eigh
per centum of his progenitors in the sixth degree were livir
in the colonies during the seventeenth century. Out of tl
total number of thirty-two, one, or perhaps two, were
Swedish blood; one a Huguenot, and one or two others fro
the Palatinate — companions of Pastorius in the founding
the first German community in America. The others we
either natives of Great Britain or their descendants estal
lished in the American colonies. Of these there were sever
of Scotch, Irish, or Scotch-Irish blood, and one or two fro
Wales.

Although in one sense only agencies in the concentratic
and transmission of the various traits derived from previo
generations, his immediate ancestors — with their person
traits, the results of education and environment — were tho
who had the most direct influence upon his character.

His father, Samuel Baird (1786–1833), was a lawyer,
man of fine culture, an independent and original thinker, an
a lover of nature and of outdoor sports.

His mother, Lydia McFunn Biddle (1797–1861), who su
vived her husband nearly forty years, was a woman of fir
executive powers, fascinating manners, and of a sunny an
equable temperament.

His father's father, Samuel Baird, served as a quarterma
ter in the Revolutionary Army; he was a surveyor, and wa
interested in the opening of coal-mines in eastern Pennsy
vania, in association with his cousin, Colonel Thomas Pott

who was the first to discover the valuable properties of anthracite coal, and who interested Franklin and Rittenhouse in devising methods for its use as a fuel. Samuel Baird's father, Thomas Baird, was of Scotch-Irish origin; he came to the colony before the middle of the century, and following the current of westward travel, settled as a frontiersman in the beautiful Cumberland Valley, near the present site of Chambersburg, the westernmost of the Pennsylvania settlements, and at the very verge of civilization. His wife, Mary Douglass, was of the same race. At the close of the Revolution, her husband having died, she, with all her children but the eldest son, joined the train of emigrants which for a quarter of a century she had seen wending westward past her door, and removed to the new territory of Kentucky, and later to Fort Vincennes, Indiana, where she was still living in 1785.

His father's mother, Rebecca Potts (1753–1830), was the daughter of Thomas Potts (1721–'62), of Colebrookdale, and granddaughter of Thomas Potts, who came from Wales to Germantown early in the eighteenth century, and was a pioneer in the development of the American iron industry. His descendants owned the region in which the Continental Army was encamped in 1778. The Valley Forge belonged to Colonel Dewees, the husband of Rebecca Potts' sister, in whose house she was living at that time, while Washington occupied the home of her uncle on the other side of Valley Creek. During that long winter Mrs. Washington taught her how to net, and gave her a silver netting-needle, still treasured by the family. Her mother was the daughter of William Pyewell (1685–1769), of Philadelphia, one of the earliest wardens of Christ Church, and her grandmothers were Magdelen Robeson, descended from Swedish colonists on the Delaware, and Mary Rutter, of Huguenot origin.

Professor Baird's mother's father, William McFunn Biddle, was the son of William McFunn, an officer of the British Navy, who was present with the fleet at the siege of Quebec, and while stationed on the Delaware was married, in 1752, to Lydia Biddle. Ordered to duty at Antigua, he contracted a disease which caused his death, at Philadelphia, in 1768. In that most interesting volume, the "Autobiography of Charles Biddle," are occasional references to Captain McFunn, who was evidently a bluff and hardy English seaman of the old heroic type. His son, William Biddle McFunn, became, by transposition of his two last names, William McFunn Biddle. He was a banker, an accomplished musician, and the friend of Robert Morris, and became involved in some of the ambitious projects which "the financier of the Revolution" organized in the early days of the Republic—especially the American Land Company. At one time the richest young man in Philadelphia, he went with Morris to a debtor's cell, where he remained until relieved by the passage of the first United States bankrupt law, in 1800. His mother, Lydia Biddle, belonged to an old Philadelphia family, for many generations prominent in commercial and banking enterprises and as officers in the Army and Navy, the descendants of William Biddle, one of the first Quaker colonists of Pennsylvania. She was descended maternally from Nicholas Scull, the friend of Franklin, one of the earliest members of the American Philosophical Society, and the first surveyor-general of Pennsylvania.

His mother's mother, Lydia Spencer Biddle, survived her husband for half a century, and died in 1858 at the age of ninety-three. Her memories of the Revolution were vivid, for her father was the patriot preacher Elihu Spencer, who had been a chaplain in the French and Indian Wars, and was despatched by Congress to North Carolina to aid in winning

over the Scotch colonists, who were slow to abandon their allegiance to the British Crown — a man whose eloquence rendered him so conspicuous that a reward was offered for his head. Her sister's husband, Jonathan Dickinson Sergeant, was a member of the Continental Congress. As a young lady at Trenton she talked with General Mercer just before he marched to his death at Princeton, and on Christmas night in 1776 saw Washington depart for the crossing of the Delaware. Her father was the brother of General Joseph Spencer of the Revolution, second cousin to Timothy Edwards, the great New England theologian, and own cousin to John and Edward Brainerd, missionaries to the Indians; she was aunt to John and Thomas Sergeant, of Philadelphia, eminent lawyers, the former a candidate for Vice-President with Clay in 1832, the latter judge of the Supreme Court of Pennsylvania. Through her mother, Joanna Eaton, she was descended from Thomas Eaton, one of the earliest American Quakers, who came to Rhode Island in 1761, and also from Thomas Wardell and Isaac Perkins, first-comers to Massachusetts Bay (1630–'35), who, as disciples of Anne Hutchinson in the Antinomian controversy, were banished from the colony as heretics, and went with the Reverend John Wheelwright beyond the limits of the colony into the forests of New Hampshire. Among her nearest of kin, the children and grandchildren of her aunts, were all the LeContes, eminent in science as zoölogists, geologists, and chemists; John McPherson Berrien, of Georgia, the "American Cicero," early Attorney-General of the United States and Regent of the Smithsonian Institution; as well as Admiral Montgomery and Commodore Berrien, of the United States Navy.

These were all representative men and women, leaders in the communities in which they lived, a group even more remarkable for their abilities than for their diversity in origin

and character. Many of them were Quakers, but there were also Churchmen, Lutherans, and Presbyterians. Among them were soldiers, sailors, clergymen, lawyers, financiers, surveyors, miners, farmers, mechanics, military officers, British and American; patriots and loyalists, Whigs and Tories, Federalists and Republicans. With such ancestral resources to draw upon, it is not strange that Professor Baird should have been a man of varied and commanding abilities. His administrative capacity, his power of directing and controlling men, and his personal charm of manner, came to him perhaps chiefly from his mother; while to his father's family he owed his love of outdoor life, his taste for the study of nature, and his magnificent physique, a heritage from generations of pioneers and frontiersmen. Those who knew him best may be disposed to attribute to his Quaker ancestry his quiet and unassuming manner, his dislike for publicity, and his preference for a simple garb of gray.

III.

SPENCER FULLERTON BAIRD was born February 23, 1823, in Reading, Pennsylvania. His father died when he was ten years old, and his mother soon removed with her family to Carlisle, a village in the beautiful Cumberland Valley, which was the seat of Dickinson College and of a government military post, and the home of many people of culture and refinement.

When he was eleven he was sent to a Friends' boarding-school, kept by Doctor McGraw, in Port Deposit, Maryland; a year later entered the grammar school in Carlisle, and in 1836 Dickinson College, from which he was graduated in 1840, at the age of seventeen.

His interest in collecting and classifying facts and in ob-

serving nature began when he was still a boy. His early note-books contain systematic lists of various kinds. He gathered specimens of the wood and leaves of plants, and at the age of fourteen joined his elder brother William, who had similar tastes, in making a collection of the game-birds of Cumberland County. Specimens prepared by these boys sixty years ago are still preserved in the National Museum.

After leaving college, since he was too young to enter any profession, he was allowed to follow his own tastes for a time, and his inclination for science developed in such a remarkable manner that his mother felt that she was justified in allowing him to devote himself for several years to his favorite pursuits. There were at that time no schools for young naturalists, and his education was in a large degree self-directed. He began to read medicine, attended a course of lectures at the College of Physicians and Surgeons in New York in the winter of 1841–'42, and made excursions, often on foot, in search of specimens and to visit collections. He made long visits to friends in New York, Philadelphia, and Washington, and thus saw the museums and important private collections and became familiar with what were at that time the principal centers of learning. In those days were formed many of the friendships and scientific partnerships which influenced his after life.

Among his early companions and correspondents were George N. Lawrence (1841), Charles Pickering and John Torrey (1842), John Cassin and James D. Dana (1843), Thomas M. Brewer, Stephen S. Haldeman, Joseph Leidy, and Frederick E. Melsheimer (1844), John G. Morris (1845), Jared P. Kirtland (1847), and Philo R. Hoy and John S. Newberry (1850).

Still earlier was his friendship with Audubon, with whom he began a correspondence in 1838, and from whom he re-

ceived instruction in making drawings of birds; and it was to him, and perhaps still more to his own kinsman, Major John LeConte, one of the early Southern naturalists, that was due his determination to devote his life to natural history.

In 1843 he translated Ehrenberg's work on the corals of the Red Sea for Dana, who was then engaged upon his report for the Wilkes exploring expedition. In 1846 he appears to have been occupied in the preparation of a synonymy of North American birds, and to have visited Boston to consult in the libraries of Amos Binney and the Boston Society of Natural History certain books not to be found in Philadelphia. That he was already at that time a trained student is shown by the fact that the material then gathered was utilized by him twelve years later in his "Birds of North America."

During all this time he was engaged in organizing a private cabinet of natural history, taking long excursions through the mountains of Pennsylvania; in making dissections and preparing slides for the microscope; and in preserving specimens, most of which are still in existence and available for scientific study in the National Museum.

In 1841 he walked 420 miles in twenty-one days; on the last day 60 miles between daylight and rest. In 1842 he walked more than 2100 miles. In the course of these excursions he visited Audubon, Haldeman, Melsheimer, and Morris, in order to examine their collections. His fine physique and capacity for work in after days were perhaps due in part to these years of outdoor life.

I find in his note-book a memorandum that on his birthday in 1840, at the age of seventeen, his height was five feet ten and a quarter inches; a year later he measured five feet eleven and three quarters inches, and weighed one hundred and fifty pounds. During his long walk in the following fall

he made some curious experiments upon himself. At night, after carrying a load of forty pounds for ten miles, he measured five feet eleven and a quarter inches, and the next morning six feet, showing that his height had been compressed by weight three quarters of an inch.

His home studies were carried on for a number of years, and were scarcely interrupted by his election in 1846 to the chair of natural history and chemistry in Dickinson College. In this capacity he taught the seniors physiology; the sophomores, geometry; freshmen, zoölogy; and the preparatory students, something else. He found time, however, to carry on the work begun in previous years and to make each summer an extended collecting expedition: in 1847, to the Adirondacks; in 1848, to Ohio, to collect, in company with Doctor Kirtland, from the original localities of the types, the species described by him in his work on the fishes of Ohio; in 1849, to the mountains of Virginia, with C. B. R. Kennerly; and in 1850, to Lake Champlain and Lake Ontario.

He remained in Carlisle until 1850, and there he married, in 1846, Mary Helen Churchill, the daughter of General Sylvester Churchill, Inspector-General United States Army. He used to say that his wife won his heart as a girl by the beautiful labels she wrote for his collections, and she was always afterward his companion and assistant in his work.

The coming of Agassiz to America in 1846 was an inspiration to the young naturalist. One of the first great works projected by the Swiss *savant* was a memoir upon the freshwater fishes of North America, in the authorship of which Professor Baird was to be his associate — a work which was never completed.

Agassiz did not establish himself in Cambridge until 1848, and to Baird should belong the credit of having introduced into American schools the system of laboratory practice and

field exploration as an essential part of instruction in natural history. Doctor Moncure D. Conway, one of his pupils, has often spoken to me of his fascinating explanations of natural phenomena, and how the contagion of his enthusiasm spread among his pupils, who frequently followed him over the hills twenty or thirty miles a day. Once, while collecting insects in the field, they were surrounded and captured by a party of German farmers, who thought they were escaped lunatics and proposed to take them to an asylum.

IV.

His mentor at this time was the Honorable George P. Marsh, of Vermont, who was always his friend and admirer, and to him Professor Baird always felt that he owed his real start in life. Mr. Marsh, feeling that his protégé was disposed to bury himself in the technicalities of a specialty, insisted that he should undertake to translate and edit an edition of the "Iconographic Cyclopædia," a version of Heck's "Bilder-Atlas," published in connection with the famous "Konversations-Lexikon" of Brockhaus. This, his first extensive literary task, though exceedingly laborious and confining to a man so young and entirely untrained in literary methods, was efficiently and rapidly performed. The result was a great expansion in his tastes and sympathies, while the training and confidence which he acquired served as an excellent preparation for the tremendous literary tasks which he undertook without hesitation in later years.

It was also to Mr. Marsh, who was one of the earliest Smithsonian Regents, that he owed his election as Assistant Secretary of the Institution, then recently organized. His selection, as is indicated by a statement in Professor Henry's fifth report, was due quite as much to his training in editorial

methods as to his professional acquirements. His appointment, as is there stated, was made at that time more particularly that he might have charge of the publications, and that the Institution might take advantage of the ample experience which he had gained in editorial work.

He first met Henry, as his diary shows, on July 17, 1848, visited with him the building then being constructed, and undertook to collect natural history objects for the Smithsonian.

The Regents of the Institution did not, of course, appreciate the fact that he had originated, in connection with his work upon his own private collections, a system of museum administration which was to be of the utmost value in the management of the great National Museum, which developed so rapidly under his charge.

All the efficient methods which are now in use in the National Museum were practised in the little museum which he had organized at home, and which he brought with him to form the nucleus of the Smithsonian collection. Among the treasures of his cabinet, which filled two large freight-cars, and which are still cherished by the Institution, were a number of the choicest bird skins collected by Audubon, who entertained for him a sincere friendship from the time when he proposed to him, a boy of nineteen, that he accompany him on a voyage to the headwaters of the Missouri, and who sought him as partner in the preparation of the great work "Quadrupeds of North America."

The position of Assistant Secretary was accepted July 5, 1850, and on the third of October, at the age of twenty-seven years, he entered upon his life-work in connection with the Smithsonian Institution.

V.

It would be interesting to dwell upon the details of his work, but his life was so full of interests that it is only by careful condensation that even an adequate outline of its eventful features can be presented in this volume.

There were several distinct activities in his career, distributed somewhat as follows: (1) a period of twenty-six years (1843–'69) devoted to laborious investigation of the vertebrate fauna of North America; (2) forty years (1840–'80) of continuous contribution to scientific literature, of which at least ten were devoted to scientific editorship; (3) four years (1846–'50) devoted to educational work; (4) forty-one years (1846–'87) devoted to the encouragement and promotion of scientific enterprises, and the development of new workers among the young men with whom he was brought into contact; (5) thirty-seven years (1850–'87) devoted to administrative work as an officer of the Smithsonian Institution and in charge of the scientific collections of the government — twenty-eight years (1850–'78) its principal executive officer and nine years (1878–'87) the Secretary and responsible head of the Institution; (6) sixteen years (1871–'87) as head of the United States Fish Commission, a philanthropic labor for the increase of the food supply of the world, and incidentally for the promotion of the interests of biological and physical investigation.

VI.

The published list of his writings contains over one thousand titles. Although very many of these are brief notices and critical reviews, and a considerable number are reports and other official publications, there still remain two hundred which are formal contributions to scientific literature.

His work in ornithology was, perhaps, the most extensive and that which contributed more than any other to his reputation; for although he published only eighty papers, several of them were monographic, and so exhaustive and critical in their character that their publication was epoch-making.

The first of his large works, the "Birds of North America," which constituted the ninth volume of the reports of the Pacific Railroad Survey, was published in 1858, a quarto work of more than one thousand pages, which for twenty years remained the principal authority. Indeed, this and his "Review" are still regarded by every American ornithologist as absolutely indispensable for constant reference. Coues has declared that with its publication began the "Bairdian Period" in American ornithology, a period covering almost thirty years and characterized by an activity without a parallel in the history of the science. "It represents the most important single step ever taken in the progress of American ornithology in all that relates to the technicalities. The nomenclature is entirely remodeled from that of the immediately preceding Audubonian period, and for the first time brought abreast of the then existing aspect of the case. It was adopted by the Smithsonian Institution, and thousands of separately printed copies of the 'List of Species' were distributed during succeeding years to institutions and individuals; the names came at once into almost universal employ, and so continued, with scarcely appreciably diminished force, until about 1872."

"The appearance of so great a work, from the hands of a most methodical, learned, and sagacious naturalist, aided by two of the leading ornithologists of America [John Cassin and George N. Lawrence], exerted an influence perhaps stronger and more widely felt than that of any of its predecessors, Audubon's and Wilson's not excepted, and marked

an epoch in the history of American ornithology. The synonymy and specific characters, original in this work, have been used again and again by subsequent writers, with various modification and abridgment, and are in fact a large basis of the technical portion of the subsequent 'History of North American Birds' by Baird, Brewer, and Ridgway. Such a monument of original research is likely to remain for an indefinite period a source of inspiration to lesser writers, while its authority as a work of reference will always endure."

In pursuance of the same thought, Coues, Stejneger, Dall, and Ridgway have united in the characterization of what they call the "Bairdian School of Ornithologists"; a school characterized by exactitude in matters of fact, conciseness in deductive statement, and careful analysis of the subject in all its various bearings; a school whose work is marked by a careful separation of the data from the conclusions derived from them, so that the conclusions or arguments can be traced back to their sources and duly weighed.

As Doctor Stejneger has shown, the writings of the older European naturalists afford little basis for analysis, and the investigator has no recourse but to accept an author's statements and conclusions on his own responsibility.

It is scarcely probable that any American naturalist would have ventured to claim for a fellow-countryman so radical an advance in scientific method, but I am not aware that the generalization of Stejneger has met with any opposition abroad. Indeed, during the twelve years which have passed since Stejneger's characterization of the Bairdian School, its methods have been generally adopted among advanced workers on the other side of the Atlantic.

The development of this school was due not alone to the publication of the "Birds of North America," but still more to the direct influence of its author, exerted by personal inter-

course and by correspondence upon a large number of American naturalists and collectors, and it is due in part to his influence that ornithology is to-day being pursued in this country by a larger number of competent and well-equipped naturalists than any other branch of natural history.

The publication of the "Review of American Birds" was begun in 1864, but never completed, having ceased with the issue of the first volume. This has been described by competent authorities as a work of unequaled merit, displaying in their perfection the author's wonderful powers of analysis and synthesis — a work which has received unstinted praise from all competent to estimate it, and one which has made a more profound impression on foreign ornithologists than any other single work on American birds.

There were numerous minor contributions to ornithology, but no other great one from his unaided pen. The monumental "History of North American Birds," in five volumes, by Baird, Brewer, and Ridgway, presented fully the results of the labors of the Bairdian School up to 1874; and his favorite pupil and assistant, Mr. Ridgway, is now engaged upon a most important systematic treatise, which, as a summary of all that is known of the morphology and classification of the birds of north and middle America, will, when it is published, repeat in its effect the volume of 1858.

In his early years he published many minor papers upon the mammals of the West, and in 1857 appeared the eighth volume of the Pacific Railroad Survey Reports, which was devoted almost entirely to the mammals of North America. Nearly forty years have elapsed, and still no general work has been published to take its place. Everything which has been said in previous pages about his "Birds of North America," published in the same series in the following year, applies with equal or greater force to his work upon the

mammals. The greatest of living American mammalogists said to the writer not long ago, that in his work to-day, when he had a description by Baird before him, he did not deem it essential to examine the specimen to which it related; something, he added, which he could not say about any other writer.[1]

In the field of herpetology Professor Baird was still more of a pioneer, and, with the exception of Cope, to whom he resigned the field in 1859, as his chosen successor, his formal memoirs in this department were more extensive than those of any other. In his day material did not exist for a comprehensive work covering the entire continent, but in his elaborate reports upon the collections of the transcontinental surveys, and in his catalogue of North American Serpents in the collection of the Smithsonian Institution, as well as in his scattered papers, he very nearly covered the same field which was occupied by his two great volumes on birds and mammals.

Nearly two hundred new species and numerous new genera of reptiles were discovered and named by him, either under his own name or in association with his assistant, Charles Girard. To illustrate the fundamental character of this work, it may be said that when the great collection of snakes, containing several thousand specimens, was taken up for study, each specimen was individualized by attaching a number tag, which served as a key to its locality. They were all then thrown into one great pile, and by a process of comparison with absolute disregard for what had previously been written, assorted, first into families, then into genera, and then

[1] To illustrate his methods of work and the facility which he acquired with practice, it may be stated that he began the mammal volume in Elizabethtown, New York, August, 1853, and finished printing July, 1857; he began the bird book in August, 1857, finished writing July, 1858, and printing October, 1858; having in the last instance written about two thousand quarto pages of original matter of the most technical character within a period of eleven months, and put it through the press in the three which followed.

into species and varieties. After this had been done, descriptions and analytical keys were prepared and provisional names were given to each. Last of all, the books were consulted in order to determine which of them had already been described and provided with names. Never in the history of zoölogy has a continent been classified in a manner so free from complications of previous discussion.

He published little on the morphology and classification of fishes. A few papers, in association with Girard, upon new forms found in the fresh-waters of the Southwest, and a report upon the fishes observed upon the coast of New Jersey and Long Island during the summer of 1854, were early and useful pieces of work, though not especially significant.

After he became Commissioner of Fisheries his time was so occupied that he was obliged to carry on his studies through the agency of others. In his first annual report, however,—that for 1871,—he discussed the life-histories of two important economic species, the bluefish and the scuppaug. These were the beginning of a new method in ichthyological work, and served as a model and guide for all the more recent American students. These essays were life-histories of the most comprehensive type. In them he discussed geographical range, migrations, movements, habits of life, phenomena of reproduction and growth, questions of food, enemies, temperature, and all the manifold relationships of each form to its environment. Then followed a discussion of the relation of these fishes to man, the relative destructiveness of different methods of capture, and the effects of these methods in the past. The evidence in regard to the diminution of numbers was critically examined, and the statistics for the region, with which he was familiar, were treated in an exhaustive manner. A life-history equal to that of the bluefish, then printed, has never been written by any other naturalist.

It was his intention to have continued this series of papers, and had the scope of the Fish Commission not been subsequently expanded so as to include artificial culture, he would probably have been able to do this for all the fishes of the Atlantic coast. His material in regard to the herring and menhaden was particularly abundant and important.

After six years of waiting, however, he decided that it was impossible for him to give his personal attention to work of this kind, and in 1877 he proposed to me to take up the work, at the same time handing over a great mass of classified material — his own observations supplemented by letters and extracts relating to all the economic fishes of the United States. This was the foundation of the somewhat voluminous publication entitled "The Fishery Industries of the United States," which was published under his direction by the writer and a staff of associates.

Although he had abandoned this portion of the work, he by no means lost interest in it, but had in preparation at the time of his death a paper which, had he completed it, would have been one of the most important contributions to the literature of the fishes ever issued, dealing as it did in the broadest and most philosophical manner with the principles underlying the whole subject of fishery economy.

He attempted in later years no personal work upon the fishes, but he saw every specimen obtained by the Commission and inspected every collection, as soon as it was received, with eager enthusiasm. He was often the first to detect undescribed or novel forms, and knew more about them all than the men whom he designated to write accounts of them.

It was so also with the invertebrates, especially in the early years, before the extension of the investigation into the deep sea brought in such an overwhelming wealth of new material.

It was so in the Museum in every department, and each of his associates knew that he was many times competent to do the work which he had made over to others.

Particularly keen was his insight into North American archæology. The great collection of the Smithsonian Institution grew up under his hands, and up to the time of his death every single object was handled by him as soon as it was received. No one was so quick to perceive a new fact or so keen in the detection of a fraud, and although he never published a formal contribution to archæology, there was in his day no archæologist in America who was so learned. He was, indeed, an "all round" naturalist—one of the last of a school which has now almost ceased to exist.

But that he, like Professor Henry, was willing to give up the pleasure of doing things himself, in order that he might provide the means by which hundreds of others might be enabled to work, the sum total of his contributions to science would have been much greater.

It was his self-chosen task to amass material for research, to secure the money for the prosecution of studies upon it, to select the men, to train them and point out to them the results to be accomplished, to watch their progress, and, when satisfied that an adequate result had been reached, to secure its publication. Like most men of active mind, he delighted to enter unfamiliar regions, to become thoroughly familiar with all that was known, and to begin some research in each field in order to satisfy himself of his competency to enter it if he chose. This having been done, he was quite willing to hand over his accumulations of notes and material to some one else, and to this trait of his character many naturalists since prominent have owed their first establishment in the fields of research which they have since occupied.

Reference has been made to the characteristics of the

Bairdian Period and School of Ornithology, which have been recognized. No one has proposed similar periods and schools in other departments of zoölogy, but in mammals particularly there is even more justification for the use of these terms, for his influence is here even more dominant to the present day. Indeed, these terms might well be extended to cover the entire field of systematic zoölogy in North America, in which he has been even more prominent than was his contemporary Agassiz in the related field of animal morphology.

VII.

THE most judicious estimate of the biological work of Baird is, perhaps, that presented by Doctor Billings in his memoir read before the National Academy in 1889.

Doctor Billings points out that his writings contain not merely descriptions of a large number of new species, but a general revision of the classification and nomenclature, and that the principles upon which these were founded have for the most part stood the test of time, showing the keenness of his insight into what may be called "fundamental morphology." His larger works are still standards of reference, and the additions which have been made to them are mainly the work of his own pupils or of those who have been trained in his methods. His work was necessarily confined to descriptive morphology, systemization, and nomenclature, but his early training as a field naturalist entirely removed him from the category of mere species describers. His determinations were founded mainly on bones and skins, which formed the bulk of the material available at the time.

"It is not," continues Doctor Billings, "an easy matter to estimate fairly the importance of this kind of work and the influence which it has on scientific progress and general cul-

ture, and it is very likely to be either under- or over-valued by those who are not familiar with the study of living organisms. Classification, description, and naming of the different forms are the essential foundations of scientific biology, for until this has been done identification of particular forms is either difficult or impossible, coöperative work on the part of scattered students is greatly restricted, and broad generalizations can only be put in the form of theories and conjectures. Such work as was done by Professor Baird in this direction gives a starting point to many observers and investigators in different localities, stimulates farther inquiry, and, when done on the extensive scale on which he did it, based on the examination and comparison of a large number of specimens from widely different localities, exercises a powerful influence for years to come on lines of exploration, collection, and critical research. To those who have never tried it, it may seem an easy matter to sort out specimens of different kinds when a large number are brought together, or to prepare descriptions sufficient to enable another man to identify his specimen; but in reality it requires not only much experience and careful study, but a certain aptitude, power of grasping salient points, and of putting aside unessentials such as are rarely possessed by any man."

As an example of Professor Baird's ability in generalization, Doctor Billings cites his paper on the distribution and migrations of North American birds. In this he maps out the country into regions corresponding to the distribution of different kinds of birds; discusses the relations of these regions to surface topography, altitude, temperature, mountain chains, etc.; points out that there are certain correspondences in the distribution of reptiles and fishes, and draws the conclusion that North American birds of wide distribution in latitude, whether migrants or residents, will be found to be larger

the higher the latitude of their place of birth; that specimens from the Pacific coast are apt to be darker than those from the interior, and that specimens from near the line of junction of two well-marked provinces or regions often show the influence of hybridization. When he comes to discuss migrations, it is in their relations to the laws of the winds of the Northern Hemisphere that he studies them, and concludes that the transfer of American birds to Europe is mainly due to air currents.

He did not himself produce much of this sort of scientific literature, for he had not the opportunity, since at the very period of his career when he was best fitted to make such studies, he had to give almost his whole time and energy to routine administrative duties. "This paper alone," says Billings, "is sufficient evidence of his capacity for generalizing from a series of isolated facts."

"The two men," continues Billings, "who have exerted the strongest influence upon natural history studies in this country are Louis Agassiz and Professor Baird. In many respects they were very unlike; circumstances gave them widely different fields, and they worked on different plans and by different methods. They began their public career in this country almost together; but Agassiz was already famous as the result of seventeen years' incessant work, while Baird was an almost unknown youth. Agassiz was a born teacher, a fascinating lecturer, gifted with eloquence which won its way everywhere; Baird could only speak freely in the presence of a few, and for the most part taught only by the pen and by example. Each of them created a great museum in spite of many obstacles, the first winning the means largely from private contributions, which were a tribute to his eloquence; the second gaining his end more indirectly, through his connection with the Smithsonian Institution and government. Each of them gathered around him young men

who were stimulated and encouraged by his example, who followed his methods, have continued his work, and have taught others, so that there are now observers and workers almost everywhere. The first made great use of the microscope and of embryology; the second very little, for he had to use the material available. The first had a vivid imagination which led him to frame many theories and hypotheses to be verified or disproved by future investigation and research; the second classified the facts before him, but theorized very little. Professor Baird's career as an original investigator was hampered and finally stopped by his administrative work, but in proportion as this latter increased he was able to furnish materials and opportunities for others. The pupils of Agassiz and Baird are the working naturalists of to-day and the teachers of those who are to come, and the two methods of study are being combined and developed to produce results of which we already have good reason to be proud, and the end of which no man can foresee."

VIII.

The influence of Professor Baird in the encouragement of scientific enterprise was exceedingly great. The relation of the Smithsonian Institution to scientific exploration, especially in natural history and ethnology, is for all time inseparably connected with the history of the country. This department of its work was from its inception under the direction of the Assistant Secretary, and so intimately through him was the Institution connected with the scientific work of the exploring expeditions that the annual reports from 1851 to 1871 contain what is practically a complete history of the work of the government in the exploration of the great unknown regions of the West. This constitutes, in fact, the

only systematic record of government explorations for this period which has ever been prepared.

The decade beginning with 1850 was one of great activity in exploration. Our frontier was being rapidly extended toward the West, but in the territory between the Mississippi were immense regions which were entirely unknown. Numerous government expeditions were sent forth and enormous collections were gathered and sent to Washington to be reported upon. The Institution had been designated by law custodian of these collections, and within its walls assembled the naturalists by whose exertions they had been brought together. Professor Baird was surrounded by conditions most congenial and stimulating, for he found full scope for his energy in arranging scientific outfits for these expeditions, preparing instructions for explorers, and, above all, in inspiring them with enthusiasm for the work.

To him also fell in large part the task of receiving the collections, arranging for the necessary investigations, and the accumulation and publication of the results.

The natural history portion of the reports of the Mexican Boundary Surveys, the Pacific Railroad Surveys, and the expeditions of Ives, Marsh, Stansbury, McClellan, and others, as well as those of the Wilkes exploring expedition, which remained still under investigation, were all prepared with his coöperation, and in large degree under his supervision.

This, however, was only a small part of his work, for he maintained relationships with numerous private collectors, who derived their materials, their books, and, to a considerable extent, their enthusiasm from him. The various "Instructions to Collectors," which have passed through several editions, as well as numerous circulars written with a similar purpose, originated with him.

As a result of this work, a large number of men were trained as collectors and observers; among them not a few who have since become eminent in various departments of science: Gill, Hayden, Girard, Kennicott, Dall, Bannister, Culbertson, Stimpson, Ridgway, Rathbun, Bean, Ryder, True, and Cushing. The list might be extended for many lines. Among the older men who were thus associated with him were Meek, Cooper, Kennerly, Suckley, Gibbs, Newberry, Parry, Powell — all names familiar in the history of American exploration.

Many army officers detailed for this same work became enthusiastic naturalists, and sent in important collections and notes. Some of these men subsequently became famous as military leaders. I have seen a manuscript on the "Mountain Sheep," written by General George H. Thomas and prepared for the press by Professor Baird. General Winfield Scott and General George B. McClellan both made collections of reptiles in the West, the genus *Scotophis* and the species *Pituophis McClellanii* commemorating their names; and among other monuments to men also known as military heroes are the species named for McCall, Van Vliet, Graham, Couch, Fremont, and Emory.

Even more striking was the enthusiasm of the officers of the Hudson Bay Company in the far North, and with all these men an active personal relationship was maintained.

"Collections and correspondence," writes Dall, "poured in upon Professor Baird in extraordinary quantity. Not alone was the shedding of its horn by the antelope on the Western plains, or the nesting of the canvasback among Alaskan marshes, the theme of eager letter writing. The ladies of his household might often have been seen among the shops, seeking novels for the army officer at some isolated post, a necktie for a Northern voyager, or the dress goods for a

wedding to come off on the banks of the Mackenzie during the crisp Arctic September."

The war of 1861–'65 broke rudely into these happy days, and after it closed the old relationships were never entirely resumed, although the Institution was closely related to the natural history work of the early surveys of Hayden, Wheeler, King, and Powell. Many of the Polar expeditions, and still earlier, the natural history survey of Alaska under the direction of Kennicott and Dall, were largely under the influence of Professor Baird; while later his interest in Arctic zoology manifested itself in the pains which he took to secure the appointment of naturalists as observers at the various stations of the International Meteorological Service. The important explorations of Nelson, Turner, and Murdoch in the far Northwest, and of Kumlien and Turner in Labrador, were thus provided for.

IX.

NATURAL history and the directing of explorations were only a portion of that for which he was held officially responsible, for his first duty was from the start in connection with certain departments of routine. The system of international exchanges, for instance, was organized by him in all its details. His first task after entering upon his duties on October 11, 1850, was to distribute the second volume of the "Contributions to Knowledge." In connection with his private enterprises he had already developed a somewhat extensive system of exchanges with European and American correspondents, and the methods thus established were expanded to meet the wider needs of the Institution.

He had in charge also the details of organizing the corps of meteorological observers, and for twenty years wrote out

with his own hand daily a large number of briefs of letters for the signature of the Secretary.

The development of the natural history collections was the work for which he cared the most. As has already been indicated, the private collection which he brought with him to Washington formed the nucleus of the Smithsonian Museum. The only specimens in the possession of the Institution at the time of his arrival were a few boxes of minerals and plants. The gatherings of the Wilkes expedition — the legal nucleus of the Museum — were at that time under the charge of the National Institute and arranged in the Patent Office building; but it was not until 1857 that the Regents finally consented that this material should be transferred to its building. Before this time Congress had granted no funds for the support of the Smithsonian cabinets, and its collections had been acquired and cared for at the expense of its own endowment. They had, however, become so large and important before 1857 that the so-called "National Collection" at that time acquired was but small in comparison.

The National Museum had thus a double origin, its actual, though not its legal, nucleus having been the collection assembled at the Smithsonian prior to 1857. Its methods of administration were the very same which had been developed by Professor Baird in Carlisle as early as 1845, and are still in use, having stood the test of nearly fifty years without any necessity for their modification having become apparent.

In the fifth annual report of the Institution, now exceedingly rare, is a communication by the Assistant Secretary in charge of the Natural History Department, which after enumerating the specimens belonging to the Museum January 1, 1851, discussed fully the possibilities for the development of natural history collections in Washington—a remarkable

paper in which the germs of all future development were embodied.

The period of the Civil War was one of comparative quiet, though much was accomplished by Baird and his pupils; and his two most scholarly memoirs — the "Review of American Birds" and the "Distribution and Migrations of North American Birds"— were then written.

During this decade were continued the summer expeditions, usually extending through a period of two or three months, which were yearly more and more exclusively devoted to the investigation of aquatic life, and ultimately led to the organization of the Fish Commission in 1871.

During this period, too, the tendencies toward interest in the problems of general science growing out of his early connection with the "Iconographic Cyclopædia" began to revive, and he felt a new interest in the popularization of scientific subjects.

At the solicitation of Mr. George W. Childs, he took charge in 1867 of the column of scientific intelligence in the Philadelphia *Public Ledger*, and about 1870 became the scientific editor of the periodicals published by Harper & Brothers, of New York. His connection with this firm continued until 1878, and in addition to his contributions to other periodicals, there resulted eight volumes of the "Annual Record of Science and Industry." About the time he became Secretary of the Institution these editorial labors were abandoned, but the idea of the annual record was continued in the appendices to the Smithsonian Report until 1888 under the title of "Record of Progress."

X.

IN 1871 an entirely new interest was intrusted to his care, when he was appointed by President Grant United States

Commissioner of Fish and Fisheries. The duties of this office, although not permitted to interfere with his other official work, occupied nevertheless a large portion of his time and much of his best thought for the remaining years of his life.

The interests of the Fish Commission, so limited at first that they were performed largely by himself and a few volunteer associates, soon became so extensive that he was obliged to give up personal studies and to work entirely through the agency of others. So rapidly did the work extend in later years that notwithstanding the large and competent staff which the increased appropriations enabled him to employ, the burden of routine grew greater than he was able, with his other responsibilities, to endure, and led to his untimely death.

The work of the Fish Commission while under his charge was the most prominent of all the efforts of the government in the way of aggressive scientific research.

The law which authorized the appointment of a Commissioner of Fish and Fisheries defined his duties as follows:

"To prosecute investigations and inquiries on the subject [of the diminution of valuable fishes], with the view of ascertaining whether any and what diminution in the number of the food-fishes of the coast and the lakes of the United States has taken place; and, if so, to what causes the same is due; and also whether any and what protective, prohibitory, or precautionary measures should be adopted in the premises; and to report upon the same to Congress."

The same resolution required that the Commissioner should be a civil officer of the government, of *proved scientific and practical acquaintance with the fishes of the coast.* Only one man was eligible under these conditions. Indeed, the office had been made for Professor Baird.

The work of the Commission was at first limited to the investigation of the causes of the decrease in the food-fishes of the Atlantic coast, and it was in this connection that the summer stations were established in successive years at Eastport, Noank, Portland, Newport, Gloucester, Providence, and finally at Woods Hole, where a permanent station and biological laboratory were erected. It soon came to pass that the Great Lakes and also the rivers were included in the province of the Commission, and that the Commissioner was required to undertake extensive operations in practical fish-culture. This last has now become the most prominent part of the work of the Commission, but was in early years regarded by Professor Baird as incidental to his own interest, which was to discover the facts upon which fish-culture, fishery legislation, and fishery economy in general, must of necessity forever rest.

In making his original plans, he had insisted that to study only the food-fishes would be of little importance, and that useful conclusions must need rest upon the broad foundation of purely scientific investigation. The life-histories of economic species were to be understood from beginning to end, but no less requisite was it to know all about the animals and plants upon which they feed or upon which their food is nourished; the habits of their enemies and friends, and the foes and friends of their friends and enemies; as well as the currents, temperatures, and other physical phenomena of the waters which are so intimately related to migration, reproduction, and growth.

In furtherance of these views, he carried on an exhaustive biological survey of the waters of the United States and of the adjoining regions of the Atlantic and Pacific. What was done by the *Fish Hawk* and the *Albatross*, vessels designed by him and constructed under his personal supervision, has given to our nation a most honorable place among the Gov-

ernments of the world in the field of deep-sea research. The achievements of the British ship *Challenger* are famous throughout the world on account of the magnificent series of reports, published by the Government, based upon its collections. The material accumulated by Professor Baird's vessels was quite as extensive, and had he lived the reports would have been equally famous.

The marine biological laboratory at Woods Hole is the most extensive, and at the time of its completion was one of the best equipped, in the world. Had his plans for it come to fruition, it would have been without a rival among such establishments.

Notwithstanding his own taste and inclinations, all personal work in natural history was soon abandoned to others, and his own great powers of administration applied to the practical side of the work—a task for which he had little personal liking. He nevertheless did it with enthusiasm, since he was convinced that the increase in the food supply which he was thus rendering practicable was of the greatest importance to millions of his fellow-citizens. To him was due the inception of what I have termed "public fish-culture," to distinguish it from all previous work of this kind, performed, as it always had been, upon a limited scale, and for the benefit of a few individuals.

"Public fish-culture" is fish-culture for the benefit of the masses. It does not depend for its effectiveness upon the assistance of protective legislation. It is based upon the idea that it is better so to increase the supply of fishes by artificial propagation that protective laws are not necessary; that it is cheaper to make fish so abundant that the fisheries need not be restricted, than to spend large sums of money in preventing people from fishing. "Public fish-culture" is essentially democratic and American. In 1883 I wrote: "'Public fish-

culture' scarcely exists except in America, though in Europe many eminent men of science appreciate its importance and are striving to educate the people up to the point of supporting it." These words, after the lapse of thirteen years, are still true.

In 1883 Professor Huxley remarked: "If the people of Great Britain are going to deal seriously with the sea fisheries, and not let them take care of themselves, as they have done for the last thousand years or so, they have a very considerable job before them, and unless they put into the organization of the fisheries the energy, the ingenuity, the scientific knowledge, and the professional skill which characterize my friend Professor Baird and his assistants, their efforts are not likely to come to very much good." "I do not think," he added, "that any nation at the present time has comprehended the question of dealing with fish in so thorough, excellent, and scientific a spirit as the United States."

The juries of the Fishery Exhibition in Berlin in 1880 said in their official report: "We must thank America for the progress which fish-culture has made during the past decade."

The principal French authority, M. Raveret-Wattel, wrote: "Nowhere has a Government given so much enlightened care to the rational cultivation of the waters, and afforded such efficient protection and generous encouragement."

The importance of his services to fishery economy were perhaps more fully recognized in Germany than elsewhere. At the first great International Fishery Exhibition,—that held in Berlin in 1880,—the magnificent silver trophy, the first prize of honor, was awarded to him by the Emperor. His portrait was placed over the entrance to the American court, and Herr von Behr, president of the German Fishery Union, never passed beneath it without taking off his hat in honor of

the man whom he delighted to call the "first fish culturist of the world": he insisted that whoever might be in his company should follow his example, and the late Emperor Frederick, at that time Crown Prince and "Protector of Fisheries," did homage in the same manner to the American philanthropist.

The German Fishery Union issued a circular immediately after his death, which contained the following appreciative eulogy:

"Ein edler Freund in weiter Ferne,—ein Wohlthäter des Deutschen Fischerei-Vereins, ist dahin geschieden. Wir trauern am Grabe des uneigennützigen, schlichten Gelehrten, der ein langes Leben lang den Austausch geistiger Arbeit zwischen Europa und Amerika auf vielen Gebieten der Naturkunde gepflegt hat, der seit Jahren auch unermüdlich bestrebt war, von dem Reichthume amerikanischer Gewässer an Deutschland abzugeben. Keines Lobes oder auch nur Dankes gewärtig, hielt sich Professor Baird täglich und stündlich bereit, Fragen zu beantworten und Aufschlüsse zu ertheilen. Noch mehr; aus eigenem Antriebe bot er dem befreundeten deutschen Fischerei-Verein das beste an, was nach seinem gewiegten Urtheile sich für uns eignen konnte. Ihm verdankt die Fauna unserer vaterländischen Ströme seit 1878 die Zuführung von nicht weniger als vier der edelsten Fische aus dem Salmonidengeschlechte, die sämmtlich bereits durch Nachzucht unser bleibendes, gesichertes Eigenthum geworden sind, nämlich: des Binnensee-Lachses (landlocked salmon), der Regenbogenforelle (rainbow trout), des Bachsaiblings (brook trout), und der amerikanischen Märane (white fish). Auch den in Amerika so beliebten Black Bass und den Catfish (Zwerwels), von dem wir uns Nutzen für die heimischen Ströme versprechen, danken wir ihm. Nicht weniger als zehn Millionen befruchteter Eier mögen in seinem Auftrage aus den unermesslichen Schätzen, über welche die 'United States Commission of Fish and Fisheries' zu verfügen hat, über den Ocean uns zugegangen sein.

"Herr Spencer F. Baird war es auch, dessen kräftiger Förderung wir i. J. 1880 den Entschluss der Bundesregierung, die berliner internationale Ausstellung zu beschicken, wesentlich verdanken. Mit solcher Umsicht und mit so grossartiger Vollständigkeit wurde die amerikanische Abtheilung derselben ausgerüstet, dass man sie ohne Weiteres als die lehrreichste und wichtigste aller Ausstellungen der Fremde bezeichnen konnte, so dass der grosse Ehrenpreis Sr. Majestät des Kaisers dem Professor Baird zugesprochen wurde.

"Möge Amerika die Verdienste des edlen Mannes eingehend darstellen und dauernd ehren, der das Ehrenamt als Vorsitzender der genannten Kommission, durch überreiche Zuwendung der Bundeskasse und die Freigebigkeit der Eisenbahngesellschaften unterstützt, mit so kräftiger Initiative zur Erneuerung des bereits dezimirten Fischbestandes ausnutzte,— der die nur in einzelen Stromgebieten heimschen Fische allen andern im Osten und Westen des gewaltigen Landes zugänglich machte,— der sogar Dampfschiffe bauen liess, um sie als bewegliche Bruthäuser zu benutzen,— dem auch jeder Versuch willkommen war, europäische Fische drüben zu akklimatisiren. Dass wir in letzterer Hinsicht dem unvergesslichen Freunde auch unserseits haben dienstbar sein können, gereicht uns zur lebhaften Genugthuung. Zwei dem amerikanischen Festlande früher unbekannte Arten, der Karpfe und die Forelle, sind von Deutschland aus dort eingeführt worden. Beide mit staunenswerthem Erfolge. Der Karpfe, namentlich, hat drüben (wenn der Ausdruck gestattet wird) ein neues Leben begonnen. Wie er in kürzester Frist zu kaum gekannten Massen heranwächst, so bemühen sich die Amerikaner ihrerseits mit wahrhafter Vorliebe um den Ankömmling; eine eigene Zeitschrift beschäftigt sich seit Kurzem mit den Schicksalen des Karpfen in jedem Theile der Union. Wir vernehmen mit Befriedigung, dass sein mehr jähriger Mitarbeiter, Herr Professor Brown Goode, nunmehr seine Stelle übernehmen soll. Möge der liebenswürdige Gelehrte, dessen sich viele von unserer Fischereiausstellung her erinnern werden, in die Fusstapfen seines Vorgängers voll und würdiglich eintreten. Uns wird er allezeit bereit finden,

mit ihm in demselben Geiste der Brüderlichkeit, der uns mit dem Verewigten verband, weiter zu arbeiten.

"Spencer F. Baird war am 8 Februar 1823 zu Reading in Pennsylvanien geboren. Er war Vorsteher des Smithsonian Institute zu Washington. Am 18 August d. J. verschied er zu Wood's Holl. Im Herzen seiner deutschen wie seiner amerikanischen Freunde wird er lange, lange fortleben. *Ave, cara anima!*"[1]

XI.

In May, 1878, he was unanimously elected to succeed Professor Henry as the Secretary of the Smithsonian Institution. In this position he continued the policy of his predecessor, though with more attention to exploration. The number of publications was increased and more attention paid to the development of the library. He secured legislation authorizing the expansion of the endowment fund invested in the Treasury to one million dollars, and began to agitate the question of scholarships in connection with the Institution. During his administration, too, was erected the annex building to contain the overflow of the collections of the National Museum, which had been so suddenly expanded through his influence at the Philadelphia Exposition. To the construction of this building, which covers an area of nearly two and a half acres, he gave his personal attention, and completed it for less than the amount of the appropriation, turning a small balance into the Treasury, something which has rarely happened in the erection of government buildings, and which is still remembered in Congress as remarkable.

The building has been severely criticized because of its lack of architectural dignity, but it is by far the cheapest structure of the kind ever built, the cost for each square foot of floor space available for exhibition having been only two

[1] Circular No. 4 (pages 59, 60), Berlin, October 13, 1887.

dollars and a half, while no other museum building has cost less than eleven dollars for the same unit. It was regarded by Professor Baird as a temporary structure, and he acted upon the theory, which experience has shown to be a wise one, that in order to secure for the future a museum worthy of the nation, the first necessity was a building of great capacity, in which the extraordinary opportunities at that time presented for accumulating and organizing great collections could be utilized.

The larger portion of his time was still occupied by his duties as Commissioner of Fisheries, yet the Institution and its dependencies were constantly in his mind, and the ten years of his incumbency were marked by an extraordinary expansion in every direction of the Institution's potentiality for the future.

Honors were showered upon him from every quarter of the world. The King of Norway and Sweden, in 1875, made him a Knight of the Order of St. Olaf; in 1878 he received the medal of the Acclimatization Society of Melbourne; in 1879 the gold medal of the Société d'Acclimatation de France.

He was an honorary member of many scientific societies in England, Germany, Austria, Spain, the Netherlands, Australia, New Zealand, Holland, Switzerland, Canada, and the United States. Even Japan was not unmindful of his services to science, and from distant Yezo came soon after his death a little volume printed on silk containing his portrait and an appreciation in Japanese.

A few months before his death, at the 250th anniversary of Harvard University, he received the degree of LL. D. This was one of the few occasions upon which he was ever induced to ascend the platform in a public place.

The village of Baird, in Shasta County, California, was named for him in 1877.

His most lasting memorials, however, are those living monuments which commemorate the activity of naturalists — the animals which are named for them by their disciples. Of these there are more than forty, conspicuous among which are Baird's Tapir (*Elasmognathus Bairdii*), a large mammal of Central America; Baird's Dolphin (*Delphinus Bairdii*), a species found in the Pacific waters of the United States; and Baird's Octopus, the first conspicuous new form of invertebrate discovered in the early explorations of the Fish Commission on the New England coast.

The most modest of men, Professor Baird cared not for public recognition. His indifference to self was his most conspicuous characteristic. He could never be induced to address an audience, something which seems all the more remarkable to his friends, who remember how winning was his eloquence when he talked in the presence of a few.

The power of his persuasive suavity was never better seen than when in the presence of the committees of Congress before whom he was summoned from year to year to justify his requests for money to be used in the extension of his work. He was always received with the heartiest welcome, and these keen, bustling, practical men of business, who ordinarily rushed with the greatest of expedition through the routine of the day, forgot their usual hurry when Professor Baird was before them, and listened so long as he could be induced to talk, and not infrequently would wander from the business before them to ask him questions upon subjects which his remarks suggested. A very practical evidence of their appreciation was the prompt action upon the bill, passed soon after his death, giving twenty-five thousand dollars to his widow in recognition of the uncompensated services which he had rendered as Commissioner of Fisheries.

XII.

His personal traits have been sympathetically described by intimate friends in the many eulogies which were published soon after his death, and the appreciations of his character presented by Billings, Dall, Ridgway, Sharpe, and Powell have a peculiar interest, since each writer has depicted a phase of his character especially familiar to himself. To these are now added two others, the first written by Professor John S. Newberry, who had known him as early as 1850, and the other by Professor Harrison Allen of Philadelphia, whose acquaintance was of somewhat later date.

Professor Newberry writes:

"His most marked characteristics, and those which gained the affection and admiration of all who were brought into contact with him, were his great knowledge, his geniality, and his phenomenal industry. His courtesy was proverbial, and his remarkable success in dealing with jealous and often antagonistic government departments was largely due to his tact and sagacity. He seemed always to get what he wanted, but it was by a geniality which melted down all opposition, and never by the tricks and subterfuges so common among politicians. His suavity was irresistible, making allies and helpers of friends, and disarming all antagonists.

"As a consequence of the possession of all these charming qualities, and as a reward for the kindness he was sooner or later doing to every one about him, he was without an enemy, and more popular and beloved than any other man I have known.

"I have said that his industry was phenomenal: he really seemed never to waste a moment; he had a wonderful head for details and was an ideal business man. All the innumerable ramifications of the practical work of the Smithsonian were not only known to, but were really controlled by him;

every moment of his time was occupied, and he worked with singular speed and efficiency; yet he was never hurried or flustered and never so much engrossed in his work but that he had a pleasant word for strangers, and an open ear to all the wishes or complaints of his numerous assistants and employees. When busiest in tabulating the results of the enormous collections which were accumulated at the Smithsonian by his means, if his daughter, then a child, came with any request, he turned from his work to listen to her prattle, and lent himself to her wants and wishes as though he had nothing else in the world to attend to. His wife was a great invalid, and there were days when, very nervous, she could scarcely spare him from her sight. I have known him to sit for many hours at her bedside, holding her hand in one of his while with the other he went on with his writing, ready at any instant to administer to her wants and wishes, and yet utilizing every free moment.

"His administrative abilities were of the very highest order. As has been said, he not only managed the business of the Institution in all its arrangements with remarkable success, but he instituted and carried out a system of observations and collections in natural history that covered the entire North American continent. All the departments of government were ready to make their machinery tributary to his wants; the express companies and other lines of transportation carried all his articles free, the agents of the Hudson Bay Company even to the Arctic Circle; and both officials and private persons in Mexico and the West Indies constituted themselves representatives of the Smithsonian, and were constantly sending in gratuitously collections which would have cost, if paid for, thousands of dollars. Within the United States Professor Baird had friends and correspondents everywhere, who were working along his lines in the interest of science. In all this he really was Napoleonic, and the result was that the old Smithsonian building was crowded with priceless treasures in every department of natural science, and the National Museum, his creation, was erected and filled; and now the channels he opened are bringing to

Washington such a flood of material that a new museum is absolutely indispensable for its reception.[1]

"The Fish Commission, with all its grand results, is the product of his enterprise and good management. This in itself would constitute a monument that should satisfy the ambition of any man, but it is only one of the good works of the purest, best, kindliest, and most useful man of science America has yet produced.

"He was constantly doing good to others, and was the most unselfish of men. Nothing gave him greater pleasure than to encourage and push forward the young men about him.

"Among the collections which I brought from Oregon was a woodpecker, supposed to be new. Of this he wrote and published a description, crediting the species to me without my knowledge or consent, for the credit of the discovery all belonged to him. He was just as generous in his dealings with all others, and he seemed to be entirely free from the desire for notoriety which is so common among scientific men. He had his ambition, of course, but it was of a lofty and unselfish kind, for the advancement of science; and for the accomplishment of this he preferred to encourage and help all true workers rather than to monopolize material and gain honor and fame for himself.

"Only once did I have any difference with Professor Baird. I questioned the policy of Professor Henry, who desired to make the Smithsonian a mere bureau of information and an

[1] Doctor Billings writes: "It was the possibility of creating a great museum of natural history that induced him to come to the Smithsonian, and he never lost sight of this object; but for a long time he had to work largely by indirect methods. He did not directly oppose the policy of Professor Henry, and always worked harmoniously with him, but he lost no opportunity of increasing the collections, and constantly urged that the best way to induce Congress to grant the means of caring for such things was to accumulate material worth caring for until its amount and value should be such that public opinion would demand ample accommodation for it. So early as 1853 we find him writing to his friend, Mr. Marsh, about a scheme for a national museum, and a year later he got so far as to consider plans and size of buildings, having in view apparently something like the Crystal Palace. He was not working aimlessly all those years. He could not have what he wanted just then, but he had faith in the future, and meantime went on with his duties, which Mr. Marsh [Life and Letters of George P. Marsh. Volume I, page 262]. characterized as 'answering of foolish letters, directing of packages to literary societies, reading of proof-sheets, and other mechanical operations pertaining unto the diffusion of knowledge.'" ("Biographical Memoirs of the National Academy." Volume III, page 145.)

office for the publication of such scientific papers as were too voluminous or abstract to be given to the public through other channels. The library and museum were, therefore, looked upon by him with little favor. On the contrary, I thought the Smithsonian should be a bureau of investigation, where scientific material should be accumulated and studied by the help of a fine scientific library. So I opposed the transfer of the library to the Capitol as the giving up of an important part of the machinery of the Smithsonian. Whatever Professor Baird's private views on this subject may have been he was so loyal to his chief as never to encourage or countenance any opposition to his wishes. I felt, as I feel now, that the influence exerted by the Smithsonian on the government and the people of Washington will be measured by the space it occupies and the tangible evidence it furnishes to the public of the work it is doing. So I rejoice that the Smithsonian has preserved and greatly increased its collections, until its museum is now the finest in the country, and a source of instruction and delight to the thousands on thousands who visit the capital. Time has, I think, vindicated my views with reference to the library, and it is recognized that, as one of several collections of books, a scientific library is an indispensable part of its machinery.

"An effort was made by those who were envious of the great success of Professor Baird in accumulating scientific material to have the abundant collections brought to the Smithsonian by governmental expeditions distributed to other museums. Fortunately, Professor Baird's opposition to this scheme prevented its success; yet no one, except those who were about him at the time, knows how much labor and anxiety the retention of the museum cost him. But for him, the splendid array of scientific material which is now the glory of the Smithsonian would never have been gathered or retained."

Professor Allen writes:

"My acquaintance with Professor Baird began in 1861. At that time I was studying medicine in Philadelphia, and,

since the study of the natural sciences was recommended, I was in the habit of frequenting the library of the Academy of Natural Sciences. One day, while reading Griffith's translation of Cuvier's "Règne Animal," I was approached by a gentleman who asked me what I was reading. I chanced to be looking over the chapter which treated of the bats. In the course of the conversation that ensued he advised me to go to the specimens rather than to content myself with reading about them. This was the first notice I had ever received from any one, and the advice made a deep impression upon my mind. I afterward ascertained that the strange gentleman was Professor Baird. He was often in Philadelphia, being in constant communication with Mr. John Cassin, the ornithologist, and I had many opportunities of meeting him. The training in habits of exact observation gained by studying zoölogy has been of great advantage to me in my profession, and I have always felt an indebtedness to Professor Baird for his advice and encouragement.

"During the period that I remained in the army as assistant surgeon, Professor Baird exerted his influence to obtain for me posts of duty which permitted me to pursue my studies in natural history. I remained for the most part from 1862 to 1865 in close association with him at the Smithsonian Institution.

"Professor Baird impressed me as a great organizer. His interest in men was much the same as that taken by a general in the officers under his command. It appeared to be created by a desire to get certain work done by his lieutenants, but ended in awakening in his mind an affectionate concern for their happiness. The field before him was so vast that he had need of all collaborators. Nothing appeared to give him more satisfaction than to hear of new students coming forward.

"It is too soon to estimate the value of his achievements in perfecting a scheme of a national collection. But this much can be temperately said—namely, that the plan of the magnificent museum at Washington is entirely of his own creation. The difficulties which attended the formation of this plan

were greater than is generally known. On one occasion, at least, these would have led in any other man less sagacious than himself to failure of the entire conception. He came to the Smithsonian Institution at a time when its policy was not defined. No one can now estimate as he did the obstacles to be overcome in giving shape to the materials about him; for not only the apathy of the public, but the opposition of men of influence, both in and out of Washington, had to be overcome and changed to sympathy at every step.

"Professor Baird was optimistic in his views of life, judicial in temperament, liberal in religion, catholic in his opinions, wise and shrewd in his conduct of affairs. He had a genial vein of humor. In his literary tastes he was singularly free from pedantry, and entertained a sympathy so wide that he was the most approachable of men. I have often wondered at his patience. Nothing appeared to excite him. I never saw him in ill-temper. To an extent probably without parallel in the history of science, he combined the functions of administrator and investigator. This combination did not interfere apparently with the kind of work he selected. This was purely descriptive and was pursued in a fragmentary way,—subject to innumerable interruptions and revisions without impairment. He once told me that he wrote his book on North American birds in sittings which could not have averaged over fifteen minutes. His industry was enormous. He lost no time either by impaired health or by misdirected efforts; indeed, he was a personification of systematic energy. Thus doubtless it came to pass that the ends for which he so persistently fought were achieved, and his name will be associated for all time with the first comprehensive plan for the organization of science in America."

XIII.

About sixteen years before his death, his elder brother, to whom he was devotedly attached, and who had been his associate in his earliest natural-history work, died of heart dis-

ease. As early as 1855 Professor Baird had been conscious of weakness in the same organ, probably the result of the sudden change from athletic outdoor pursuits to desk-work which accompanied his coming to the Smithsonian. In 1873, when he proposed to me to become his confidential assistant, he told me that his condition was such that all exertion, and even mental anxiety, was to be avoided at any cost. I do not doubt that this knowledge of physical weakness and the resultant discipline contributed to strengthen the calmness and self-control to which so much of his success in later years was due.

This habit had been formed in very early life. Only twice was he ever known to show anger: when, at the age of twenty, some one abused his favorite Newfoundland dog; and once in the first years of his connection with the Institution, when a confidential letter from his aged mother was opened and read by a clerk in the course of official routine.

From early youth until failing strength forbade he kept a journal of his daily pursuits, and this, together with immense piles of copy-books and letter-files, will afford a treasure to his biographer. When the history of his life and times shall be written, it will be a history of the natural sciences in America in the last two-thirds of the nineteenth century.

He once remarked to me that he was satisfied that no man's life was of such importance to the people among whom he lived that he might not easily be replaced by another who would fully fill his place. As I looked at the man before me, a giant in body and in mind, a treasury of untransferable experience and wisdom, it seemed to me that if his judgment was in general a true one, in him at least there was an exception. And so it has proved. Ten years have passed by since he died, and his like has not been found.

SAMUEL PIERPONT LANGLEY

I.

SAMUEL PIERPONT LANGLEY was born in Roxbury, Massachusetts, August 22, 1834. At the age of eleven he entered the Boston Latin School, and afterward the Boston High School, from which he was graduated in 1851. He was not sent to college, since his tastes tended at that time entirely toward mathematical and mechanical pursuits. Astronomy, the study which attracted him most, could scarcely in those days be expected to offer a career. He decided to become a civil engineer, since in that profession he would find employment for his mathematical taste, for his natural manual dexterity, and his aptness in the use of mechanical methods.

From engineering to architecture is not a distant remove, and he presently entered the office of a Boston architect, as student. In 1857 he began the practice of his profession in the West, but the panic of that year interfered seriously with his prospects. The next few years were passed in Chicago and St. Louis, leading to little profit at the time, though the business discipline and the skill as a draughtsman which he then acquired were to be fruitful of results in later years.

In 1864 he returned to Boston, having decided to abandon architecture, but with no other plans for the future. His brother, John Williams Langley, also at this time returned to his old home in Roxbury, having just finished three years of active service as surgeon in the navy. The two brothers devoted some months to the building of a telescope, and then

went together to Europe, where they remained for nearly a year. Here they studied the Continental languages and made leisurely visits to the principal art collections and to places of historic interest. In the fall of 1865 they returned to New England.

Still uncertain as to the future, but not yet supposing that its promise could possibly be in the direction of astronomy, he learned that the observatory in Cambridge was to be reorganized, and that new assistants were being selected. Presenting himself to the Director, Professor Joseph Winlock, he was cordially received, and the dream of his life was realized. He was at last to become an astronomer.

Thus at the age of thirty he began the serious work of his life. He was by no means a novice, for he had been an eager student of astronomical works, and had made with his own hands telescopes of successively larger size, one of which, with a seven-inch aperture, was mounted so effectively that it could be used in serious work of observation. Strange to say, however, he had never formed the acquaintance of any astronomer, and had scarcely, except as a tourist in Europe, visited an astronomical observatory.

From this time on progress was sufficiently rapid to make amends for his diversion to other interests in earlier years, and before he had reached the age of forty he was recognized as one of the most brilliant observers and one of the most original philosophic reasoners and astronomers of the century.

In 1866 he went from Cambridge to Annapolis, having been offered the place of Assistant Professor of Mathematics in the United States Naval Academy. Here, in connection with his other duties, he reorganized the small observatory which had been projected by Professor Chauvenet about 1860 but abandoned upon the removal of the Academy to Newport during the Civil War. He remounted and put into service

the equatorial and the meridian circles, and prepared the observatory for practical work, an experience which was to be of much service to him in the greater responsibilities of his next field of duty.

In the following year he was invited to become Director of the Allegheny Observatory, and Professor of Astronomy and Physics in the Western University of Pennsylvania, with which this observatory was connected. The university was in Pittsburg, but the observatory was seated on the crest of a lofty hill in the adjacent city of Allegheny. This position he accepted with the expectation of occupying it for a short time only; but in Pittsburg and Allegheny he was to remain and labor for twenty years to come.

In 1887 he was appointed by Professor Baird First Assistant Secretary of the Smithsonian Institution, in charge of Library and Exchanges. He still retained his place in Pittsburg, where he passed part of the year, but owing to the failing health of Professor Baird it soon became necessary for him to assume the duties of Acting Secretary. After the death of Professor Baird in 1887, he was elected to the Secretaryship.

II.

FROM early boyhood he was interested in the very questions to which the studies of his later years have been devoted. In regard to this he has recently related some very suggestive reminiscences:

"I cannot remember when I was not interested in astronomy. I remember reading books upon the subject as early as at nine, and when I was quite a boy I learned how to make little telescopes, and studied the stars through them. Later I made some larger ones, and though they were, of course, nothing like those we use here, I think myself they were very

good for a boy. One of the most wonderful things to me was the sun, and as to how it heated the earth. I used to hold my hands up to it and wonder how the rays made them warm, and where the heat came from and how. I asked many questions, but I could get no satisfactory replies, and some of these childish questions have occupied many years of my later life in answering. I remember, for instance, one of the wonders to me was a common hotbed. I could not see how the glass kept it warm while all around was cold, and when I asked, I was told that 'of course' the glass kept in the heat; but though my elders saw no difficulty about it, I could not see why, if the heat went in through the glass, it could not come out again. Since then I have spent many years in studying the way that that great hotbed, the earth itself on which we live, is, by a like principle, made warmer by the atmosphere that covers it."

Professor John W. Langley, of the Case School of Applied Sciences in Cleveland, writes in response to a recent letter of inquiry:

"My brother quite early in life showed a marked fondness for astronomy. I remember that when he was about twenty years old he used to make small telescopes. In this work I used to help him, and being his junior in years, my position was that of first assistant.

"With these early telescopes it was possible to see Jupiter's moons, and the phases of Venus; Saturn appeared as an elliptical object with a faint indication of a separation between the planet and its ring.

"Somewhat later, in the autumn of 1864, we had about three months in which both of us were free from fixed duties, and we decided to build a reflecting telescope. My brother and I had made the acquaintance of Alvan Clark, Sr., who at that time was a portrait painter. He had a studio in Tremont Street, Boston, but he was just abandoning art for optics, and his studio contained about as many lenses in an unfinished state as it did portraits, also incomplete. At this

time the Smithsonian Institution had recently published a monograph by the younger Draper, of New York, on the making of a reflecting telescope. This, and the advice of Mr. Clark, were all we had to go upon. We had a small foot-lathe and a few tools in the barn belonging to the house where we were living, and with this outfit we undertook to make a reflecting telescope seven inches in diameter by five feet in focal length, all the work on which, both optical and mechanical, was to be by our own hands, and nothing but crude material and a few necessary tools were to be purchased. Above all things, no lenses or other completed optical apparatus were on any account to be bought; we were to make it all.

"Under these conditions of limited outfit and no experience, progress was slow, but we persevered. After weeks of labor, a speculum would be assumed to have the right shape, and ready for an optical test. This generally showed all stars with wings, like small comets, and single objects like a distant flag-staff, as a double stick with an attendant company of ghosts. Then the speculum went back into the grinding bed and was wholly reshaped. Eventually all the spare time of nearly three years was spent on this telescope, but success was finally reached, the instrument showing practically perfect definition for one of its type and size; but probably the finished reflector represented at least twenty others abandoned or reground before this result was reached. My brother's interest in astronomy and his perseverance would not allow us to be satisfied with anything short of a practical degree of perfection."

In those days of boyhood, as the writer has often heard Mr. Langley relate, he was deeply interested in the question of flight, and spent many an afternoon watching the motions of hawks and other birds.

His taste for mechanical pursuits was early developed. He made all kinds of tools and instruments which were required in his boyish experiments, and the degree of his skill may be judged from the fact that he was able to grind mir-

rors, sufficiently accurate for good astronomical work, with apparatus entirely of his own making.

III.

The career of which an outline has now been presented is full of suggestions for those who have under consideration the theory of educational methods. Still more instructive is it to the student of heredity; all the more so because there exists in this case a somewhat unusual opportunity for the examination of the sources whence has doubtless been derived the power of this sturdy and potent intellect.

It often happens in America, that "smelting-pot of the nations," as Froude has called it, that among the ancestors of any individual are included not only several European races, but the residents of a number of different colonies, almost as distinct in mental characteristics and tendencies, in early days, as the several European nations. In this case it is not so. Mr. Langley's forefathers all came, in the first instance, to Massachusetts, mostly in the early part of the seventeenth century, and in Massachusetts their descendants, with few exceptions, remained until the end of Colonial days. The names of nearly one hundred and fifty of them are known, and they bear for the most part old English surnames with a slight intermingling of Welsh, and one which has a French sound. All are characteristic of Boston, and of the neighboring towns which are now actually or practically absorbed in it.[1] The mingling, in this case so potent

[1] The names, for which, for the most part, I am indebted to the antiquarian knowledge of Mr. A. Howard Clark, are the following: Allen, Anderson, Bachelder, Baker, Boylston, Bradish, Branson, Call, Clap, Clark, Corbin, Cotton, Crosswell, Davis, Deming, Dowse, Fosdick, Foster, Franklin, Goffe, Hayward, Hills, Howell, Kettell, Langley, Ludkin, Lynde, Mather, Mayo, Phillips, Pierce, Pierpont, Pratt, Reynn, Shapleigh, Sheperdson, Smith, Sprague, Stalham, Sumner, Sweetser, Thompson, Tufts, Upham, Waite, Ward, West, Wetherell, Wharff, White, Wigglesworth, Williams, Wise, Wood.

in result, has been that of families of diverse origin and occupation, such as would scarcely have been likely to come together in an old and established community.

If one were asked to say what elements it would be best to mingle to produce Mr. Langley's peculiar type of mind, the theoretical response would probably be very close to that which is found to exist in fact. Of the eighty male ancestors who have been identified, the occupations of only about thirty-five are certainly known; most of the others were probably farmers or others of quiet, retired pursuits, who lived to ripe old age, handing down to their descendants great vitality and powers of long-living. An unusual number, at least eighteen or twenty, were skilful mechanics and artisans; six at least were mariners, and most of these were sea captains. On the other hand is found a group of the most intellectual men of early New England; four of them clergymen, three school-masters, one a physician, five at least graduates of Harvard, one of Oxford, and one of Cambridge. Besides these, there were a number who were leaders in public affairs, and who aided in extending the frontier of the infant nation, and in protecting it against invaders, Indian and European. Six were members of Colonial legislative bodies, three were lawyers and judges, eight held military commissions in the Colonial wars, or in the Revolution, while among the collaterals closely related to these same ancestors were many who held representative places in the intellectual life of the young colony.

Among the ancestors were the Reverend Richard Mather, who came from Lancaster, in England; his son, the Reverend Doctor Increase Mather, President of Harvard College, and author of the first American work upon astronomy;[1] and his

[1] Kometographia, or a Discourse Concerning Comets; wherein the Nature of Blazing Stars is Enquired into: With an Historical Account of all the Comets which have appeared

grandson, the Reverend Cotton Mather, the last two both early members of the Royal Society of London; also, the Reverend John Cotton, D.D., author of nearly fifty books, all published in London,— he who introduced into New England the custom of keeping the Sabbath from evening to evening. Others were Colonel John Phillips, of Charleston, treasurer of the Province of Massachusetts; Lieutenant Ralph Sprague, lieutenant of the Provincial forces in the Pequot War, and Captain John Sprague, his son, both members of the Massachusetts General Court; William Sumner and his son, Lieutenant George Sumner, of Dorchester and Milton, both deputies to the General Court; Edward Howell, Esquire, one of the founders of Southampton (in 1642, the first English settlement within the present limits of New York), and his son, Major John Howell, both members of the Provincial Legislature of Connecticut; Captain Stephen Williams, of Roxbury, who commanded a troop of horse on the frontier from 1707 to 1712, and Colonel Joseph Williams, his grandson, who served in the Mohawk War, the Canadian campaign of 1758, and in the Revolution. Captain Samuel Langley, Mr. Langley's great-grandfather, was also a Revolutionary soldier and commanded a company of veterans engaged in the suppression of Shay's Rebellion. And then there was another military ancestor, remembered in family tradition, who always wore a red coat, and who "when he saw a man whose face he did not like, knocked him down." This may have been Joseph Pierpont, of Roxbury, who, local history tells, fought with the Honorable Captain William Montagu, brother of the Earl of Sandwich, commonly called "Mad Montagu," and drubbed him within an inch of his life; so

from the beginning of the World into this present year MDCLXXXIII. . . . As also two Sermons Occasioned by the late Blazing Stars. By Increase Mather, Teacher of a Church at Boston, in New England. . . . Boston in New England. Printed by S. G. for S. S. and sold by F. Browning. . . . 1683. octodecimo, pages (12) 1–143+1.

thoroughly, indeed, that Montagu held him in high regard ever after.[1]

Among those who were close of kin to Mr. Langley's forefathers were Michael Wigglesworth, author of that stern Calvinistic poem, "The Day of Doom," and the Reverend Nathaniel Ward, the earliest of political satirists in America, whose pamphlet, "The Simple Cobler of Aggawam," is one of the classics of our literature. There were also Doctor Zabdiel Boylston, of Boston, the successful pioneer of small-pox inoculation in America, elected to the Royal Society in 1785, in recognition of his achievements as a naturalist, and his son John Boylston, founder of the Boylston Fund; the Reverend John Cotton, who revised and edited Eliot's Indian Bible, and his brother Josiah, missionary, and author of the first vocabulary of the language of the Indians of Massachusetts; and all the Mathers,— a wonderful group of men. A little further removed were John Adams and John Quincy Adams, Presidents of the United States, and John Cotton Smith, Governor of Connecticut.

These facts, however interesting in themselves, are mentioned here solely because of their bearing upon the question of heredity. Traits and tendencies transmitted from parent to child cannot be measured and summed up in a statistical manner. The character of these can only be suggested by an enumeration like the one which has just been attempted, following in some degree the method of Galton.

It is interesting to note, in passing, that Mr. Langley, though a Yankee of the Yankees, descended on all sides from families resident in New England from two hundred to two hundred and sixty years, has none of the traits, physical or mental, which are popularly, though erroneously, supposed to

[1] Drake, Francis Samuel, "The Town of Roxbury," Boston, 1878, page 326.

be characteristic of New England, but would in Great Britain pass anywhere as an excellent example of the very best English type.

He was, as a boy, a most diligent and omnivorous reader, interested alike in literature, art, and science, and utilized the excellent public libraries of Boston, especially that of the Athenæum, and was often in attendance at the lectures of the Lowell Institute.

At the beginning of his scientific career his intellectual capital appears to have been quite remarkable in extent and character. His mind was well stocked with the best thoughts of the great minds of the past. He possessed a cultivated literary taste, ripened by an acquaintance with the art of the Old World, the effect of which was at once evident when he began to write for publication. He had skill in the manipulation of tools, machinery, and instruments of precision, and was able to direct others in their use. He was a practical engineer, familiar with the computations and the applications of mechanics and physics; so familiar, indeed, that they were mere pastime to him in their ordinary forms, and that his mind was free to rove, like that of Leonardo da Vinci, in search of abstruse and curious variants. He was a skilful mechanical draughtsman. He was a trained man of business, thrifty, alert, and progressive. Beyond all this his unjaded mind, while mindful of the most minute details, was quick to grasp the essence of the problems which he was studying. His thoughts were almost prophetic in regard to the probable result of experiments which he was about to begin, yet he was ready to seize upon new developments as they occurred, no matter how unexpected. His inquiries were forced to their results with vigorous insistence. His conclusions were developed so clearly, definitely, and positively that it was impossible to misunderstand his meaning. So clearly were

these fixed in his thought that he was able to explain them even to those entirely unfamiliar with the subject. Notwithstanding this freedom from ambiguity so characteristic of all his statements, scarcely any of the conclusions of the past twenty-five years have been called in question, or given occasion for general criticism or debate. These characteristics, it may safely be said, he brought with him to his work, as a part of his equipment. His publications of 1874 exhibited these as fully as do those of 1896; yet at the age of sixty-two he retains them all. "His eye is not dim nor his natural force abated."

IV.

WHEN Mr. Langley went to Pittsburg in 1867, he found there an observatory only in name. It consisted of a building in which was mounted an equatorial telescope of thirteen inches aperture, bought by the university from a local club of amateur astronomers. Besides this, there was no apparatus whatever, not even a clock, and the equatorial itself was without the necessary accessories. There was neither library nor endowment, and the director of the observatory was at liberty to carry on original investigations only when this could be done without neglecting his duties as instructor in the college.

Before beginning his work as an astronomer, it was imperatively necessary that he should find some means by which this work could be carried on, and to secure an income to provide for the instrumental expenses of the establishment, his object in going to Pittsburg having been, not primarily to teach, but to secure opportunity for original investigation.

From the poverty of the Allegheny Observatory came

forth a result which was of great importance to the entire country; this was the inauguration of "time service" systems.

Although the transmission of time signals from the Greenwich Observatory to the city of London was successfully accomplished a few years after the introduction of the electro-magnetic telegraph in 1844, the service in Great Britain was confined to a limited area during the next twenty-five years.

The British Astronomer Royal in 1869 stated: "The time signals pass, amongst other places, to the chief London offices of the Electric and International Telegraph Company, and thence this company sends signals automatically to about twenty of the chief towns of England, Ireland, and Scotland. The signals are also thus sent to the principal London railway stations."[1]

In America the Naval Observatory in Washington, the observatory of Harvard College, and Doctor Benjamin A. Gould, of Albany, had prior to 1869 sent out time signals for short distances, "but only in a tentative and discontinuous fashion."

Late in that year Mr. Langley, as Director of the Allegheny Observatory, submitted a proposal "for regulating from this observatory the clocks of the Pennsylvania Central and other railroads associated with it." Upon the Pennsylvania System, then comprising over 2500 miles of railroad east and west of Pittsburg, over 300 telegraph offices were located. In the year 1870 Mr. Langley inaugurated the system by which accurate time signals were communicated automatically twice daily to each of these offices, and "eventually some 8000 miles of railway were run by this single Allegheny

[1] See letter to Mr. S. P. Langley, quoted in circular of December 1, 1869, issued by Allegheny Observatory.

Observatory clock"; and to this was added the. supply of the time to the adjacent cities by a system which made it accessible to every inhabitant.

The Pennsylvania was the first great railway to establish and put into effect a systematic and permanent plan for the simultaneous transmission of time signals throughout its entire line, and to Mr. Langley is due the credit of first successfully solving the problem of transmitting time signals over this American line, many times greater in extent and much more complex in character than the comparatively short English railways, where by the method then in vogue the accuracy of the clocks in the intermediate stations depended entirely upon a comparison with watches, which, after being set by the standard clocks in the terminal stations, were sent out along the line by trainmen charged with the duty of regulating the timepieces and reporting inaccuracies.

The present system by which the railroad service of the whole continent is regulated may be said to be an outgrowth of that developed nearly thirty years ago at Allegheny by Mr. Langley. In a letter to Mr. Langley dated May 27, 1872, William Thaw, Vice-President and executive officer of the Pennsylvania Company, and Chairman of the Board of Trustees of the Allegheny Observatory, wrote: "I regard the time service as peculiarly your creation and dependent solely on you." Mr. Thaw also stated that he had communicated the fact officially in writing in a report to the Board.

The income thus derived from the regulation of the time service was applied exclusively to the uses of the Allegheny Observatory, which obtained from this source almost all its regular means for original research, amounting during the administration of Mr. Langley to more than sixty thousand

dollars. The utility of such service having been demonstrated at the Allegheny Observatory, the example was followed a year later at Harvard College Observatory, and afterward "time services" were for some years an important source of income for quite a number of the observatories of the United States.

In the course of two or three years the affairs of the observatory became somewhat stable, and there was time for original work in astronomy. Mr. Langley now began a period of laborious and minute study of the features of the disk of the sun. Indeed this was the one of the heavenly bodies which could be most advantageously studied in Pittsburg, where the heavens are usually obscured by clouds of smoke and dust. In 1869 he was chosen a member of the party sent out by the United States Coast Survey to observe the total eclipse of August 7, and was stationed at Oakland, Kentucky. His report, at this time submitted to Professor Joseph Winlock, was his first published contribution to science. In the winter of 1870 he accompanied another eclipse expedition to Jerez de la Frontera, in Spain, where he made important observations upon the coronal rays, and found that the polarization of the corona is radial.

From this period dates the beginning of that brilliant series of researches upon the solar atmosphere to which he has since devoted so much of his time, and which soon gave him high reputation at home and abroad.

His telescope study of the sun's face, completed in 1873, revealed the true character of the "granules" upon its disk, from which, according to his estimate, much over three-quarters of its light are derived. It also resulted in a better understanding of the structure and appearance of the sun-spots. His picture of "A Typical Sun-spot," first exhibited in 1873 at the Portland meeting of the American Association for the

Advancement of Science, was the result of three years' study. This was based directly upon micrometrical measurements, pictorial effect having been considered only so far as it was incidental to minute fidelity. Even now, twenty-three years after it was made, it is conceded that this drawing gives a better idea of the minute structure of the surface of the sun than is afforded by the best photographs.

His paper on "The Minute Structure of the Solar Photosphere," published in February, 1874, may be taken as a type of his best work.

> "It possesses," writes Holden, "that hardly-definable quality by which we become aware that it was written from a full mind. It is only fifteen pages long, yet we are not conscious of undue brevity. One has a sense in reading that every statement of fact, or every expression of opinion, is based upon a hundred single instances like the one which is chosen, or upon a hundred concurring judgments. It is not that you are overborne by weight, but convinced by character. This most important paper came at exactly the right time. It first summarizes the works of other recent observers which, though important, had left the subject in an entirely unsatisfying condition, and then proceeds straight to the subject in hand.
>
> "The minute details, both of the general solar surface and of the extraordinarily complex spots, are one by one satisfactorily and lucidly described, with indications of the physical conditions to which they are due; and, finally, the general bearings of all this on the received solar theories are briefly set forth. We may fairly say that this paper is fundamental. It treated of a subject of which little had been actually known, and it leaves this subject in a satisfactory and settled condition."

His detailed study of the distribution of the heat of the solar surface was begun in 1870, with the thermopile. It re- 1874
sulted in the discovery of the previously unknown thermo-

chroic action in the solar atmosphere, by reason of which, owing to the difference in wave length, it transmits heat more readily than light. Two years later, in 1876, another discovery was announced as a result of his measures of the heat from various parts of the sun's disk; this was in regard to the direct effect of sun-spots on terrestrial climates. Following up the observations made by Joseph Henry in 1845, Mr. Langley found that sun-spots exercise a direct influence on terrestrial climates by decreasing the mean temperature of the earth at their maximum. This decrease, however, he found to be so minute that it is doubtful whether it is directly observed or discriminated from other changes. Its whole effect is represented by the change in the mean temperature of our globe in eleven years, not exceeding three-tenths and not less than one-twentieth of one degree of the centigrade thermometer; but this refers merely to the direct action by the observation of the surface, and is not to be considered as the only one.

His early work upon solar heat was done with the aid of the thermopile, an instrument which, though it had been effectively used for nearly fifty years in the study of radiant energy, was found by him not sufficiently sensitive and trustworthy to be used for the more minute work which he found it desirable to undertake. It was equal to the task of measuring the radiation from different parts of the sun's disk. When, however, the heat from a given part had been spread out into a heat-spectrum, some new means of measuring the minute difference between the various parts was indispensable; and this was specially the case with the spectra formed by "gratings," now coming into general use, which, with the great advantage of distributing the energy in a "normal" spectrum, had the defect of giving extremely little heat for examination.

He, therefore, invented a new instrument, which he called the *bolometer*, — a thermometer of almost infinite tenuity and delicacy, which measured minute degrees of radiant heat with an accuracy unknown to the thermopile and greater than that of any photometric process, and which at the same time possesses a sensitiveness to radiant energy only less than that of the eye, being able in its recent constructions to recognize variations of this energy corresponding to not over one-millionth part of a degree on an ordinary thermometer.

This instrument was made in part at the cost of the American Academy of Arts and Sciences, as administrators of the bequest of Count Rumford, and its completion was announced in the paper sent to the Society December 8, 1880, and read at its meeting of January 12, 1881. The years 1879 and 1880 were devoted to elaborating and perfecting it.[1]

The action of the bolometer is based upon variation of electrical resistance produced by changes of temperature in a metallic conductor, such as a minute strip of platinum. This strip forms one arm of an electric balance, and the change in the strength of the electric current passing through it, because of this change of resistance, is registered by a delicate galvanometer. Its sensitiveness is greater than that of the most delicate thermopile possible, and its accuracy of measurement has a corresponding advantage. One of the earliest results of the bolometer work was the demonstration experimentally that the maximum of heat in the normal spectrum is in the orange, and not, as was formerly supposed, in the infra-red portion; but a larger field opened for it in the exploration of the infra-red portion, whose existence was first suspected by the elder Herschel. The bolometer showed that this region contained three-quarters of the solar energy. Before the invention of the bolometer the distribu-

[1] "The Bolometer and Radiant Energy." *Proceedings of the American Academy of arts and sciences*, 1880–81; Volume XVI, pages 342 to 358.

tion of heat in the spectrum was so almost utterly unknown that the remark by Sir John Herschel that its heat was discontinuous contained almost all our knowledge of the subject up to that time.

At the time of which we speak, comparatively recent as it is, only a few advanced thinkers held the now universal view that heat and light were not two different things, but different effects of the same thing, and the investigations now commenced with the bolometer did much to prove the correctness of the latter opinion. By continuous studies involving great labor, and the record of extremely numerous experiments (over one thousand galvanometer readings being taken on the average to a single line), there was in the course of three years' patient work established the material for a map of the principal lines in this hitherto unknown region, and the material for a new method of study of the inter-action of the solar heat and our atmosphere, which latter was shown to be a principal agent in causing them.

The bolometer has been made much more effective and has been still more recently reinforced by the bolograph, introduced in 1891 and lately perfected — a device for registering by photography the fluctuations of the needle, which thus permanently records the bolometer's indications, while by a further step these tracings are automatically converted into a linear spectrum by the use of a cylindrical mirror, a method of translation by which the fluctuations caused by the infrared tract are reduced to a form comparable to that of the upper portion of the spectrum, as ordinarily visible. In the infra-red spectrum many hundred lines have since been located in this manner.

With these instruments Mr. Langley has opened up a new department of physics. He has not only shown the existence of, but has measured the energy in, rays having a wavelength nearly twenty times that of extreme luminous ones.

While the visible or photographic spectrum includes rays of only about an octave of vibration between the waves of violet and red, the full spectrum, from the ultra-violet rays to the longest of those measured by the bolometer, embraces between five and six octaves, and still more are indicated. In one sense these investigations have partly bridged over the gulf between the longest wave-length of heat and the shortest waves due to other causes. "This work," says Lockyer, "has done for the lower spectrum what that of Kirchhoff did for the upper rays."

Father J. Van Geersdale, of Louvain, in an article on "The Infra-red Spectrum and the Bolometer," written in 1896, remarks:

"Newton would be very greatly surprised if, coming back for a moment to this world, he should have placed before him a map of the spectrum as it is known to-day. Not only would he be astonished at the numberless rays which were unknown to him, but he would be still more taken aback if he saw the spectral image lengthened until it had assumed dimensions fifteen and twenty times as great as those which he gave to it. In his day, below the violet ($\lambda = 0{,}42$), and above the red ($\lambda = 0{,}67$), there was absolutely nothing. To-day the researches of Cornu, Mascart, Schumann, and others have expanded the limits of the ultra-violet to the neighborhood of $\lambda = 0{,}1$. In the other direction, the investigations undertaken by Mr. Langley in the infra-red region have resulted in an acquaintance with bands and rays the wave-length of which reaches to six microns and beyond.

"Without depreciating the value of the researches which were made in the less refrangible portions of the spectrum previous to the discovery of the bolometer, it must be admitted that they were of very slight moment if we now compare them with those which Mr. Langley has obtained by the aid of his marvelous little instrument."[1]

[1] "Le Spectre Infra-Rouge et le Bolomètre," *Revue des Questions Scientifiques*, Volume X, page 26, July, 1896, Louvain.

Another result of these experiments was the establishment of the fact of selective absorption of the solar rays by the earth's atmosphere. In regard to this Mr. Langley wrote at the time:

"Our observations at Allegheny had appeared to show that the atmosphere had acted with *selective* absorption to an unanticipated degree, keeping back an immense proportion of the blue and green, so that what was originally the strongest had, when it got down to us, become the weakest of all, and what was originally weak had become relatively strong, the action of the atmosphere having been just the converse of that of an ordinary sieve, or like that of a sieve which should keep back small particles analogous to the short wave-lengths (the blue and green), and allow freely to pass the large ones (the dark-heat rays). It seemed from the observations that the atmosphere had not merely kept back a part of the solar radiation, but had totally changed its composition in doing so—not by anything it had put in, but by the selective way in which it had taken out, as if by a capricious intelligence. The residue that had actually come down to us thus changed in proportion was what we know familiarly as 'white' light, so that white is *not* 'the sum of all radiations,' as used to be taught, but resembles the pure original sunlight less than the electric beam which has come to us through reddish-colored glasses resembles the original brightness. With this visible heat was included the large amount of invisible heat, and, if there was any law observable in this 'capricious' action of the atmosphere, it was found to be this, that throughout the whole range of the then known heat-spectrum the large wave-lengths passed with greater facility than the shorter ones."

Most of these observations were carried on in Allegheny. In 1878, however, he made observations of the solar eclipse from the summit of Pike's Peak, at an elevation of fourteen

thousand feet, and observed the extension of the corona to the hitherto unsuspected extent of nearly ten million miles.

During the winter of 1878, in the course of a visit to Europe, he spent some time upon Mount Etna, making observations upon the character of astronomical vision, in order to enable comparisons to be made with observations taken under similar conditions in the territories of the United States. The station here was at Casa del Bosco, situated at the height of about 4,200 feet on the southeastern slope of the mountain. There he remained from Christmas until January 14. The conclusion reached was that though the ideal station where atmospheric tremor does not exist, and the observer pursues his studies in an ever transparent sky, is not to be found on any part of the earth's surface yet examined, there is in such stations as this and in the upper and elevated tablelands of Colorado and New Mexico every condition which experience has shown to be favorable.

In 1881 Mr. Langley organized an expedition to the top of Mount Whitney, in California, for the purpose of applying his new methods and instruments under the most favorable conditions. Here he remained with his party from July 25 until September 10, making observations at stations nearly fourteen thousand feet above the sea. The expenses of this expedition were borne in part by the United States Signal Service and in part by William Thaw, of Pittsburg, who had for some years taken great interest in the work of the Allegheny Observatory and to whose liberality and appreciation of scientific work many of Mr. Langley's greatest opportunities for investigation were due. A report on the results of this expedition was published in 1884, as one of the professional papers of the United States Signal Service.

The Mount Whitney observations resulted, first, in the discovery of an entirely unsuspected extension of the solar

spectrum; second, in a calculation of the relative intensity of the different rays of the sun before they have entered the earth's atmosphere, which was illustrated by an extra atmospheric curve in the spectrum; third, in the indication that scarcely sixty per cent. of the solar rays penetrate to the earth's surface, the atmosphere as a whole exerting a powerful selective absorption; and finally, in a new and important estimate of the "solar constant." The effect of such absorption on the visible rays is to throw out the shorter wavelengths much more effectively than the longer ones, so that to an eye outside the earth's atmosphere the sun would appear far bluer than to one within, and the estimated amount of heat before absorption is correspondingly measured.

The total absorption of the heat rays was found to be surprisingly great. These experiments then demonstrate that a much greater amount of solar heat reaches the earth than had previously been supposed, sufficient, in fact, to melt each year an ice shell encrusting the earth to the thickness of 179 feet, instead of 110 feet, as had before been believed. It was also found that the law of selective absorption modifies profoundly the terrestrial manifestations of the heat supplied by the sun, and that were there no such selective absorption, the temperature of the soil in the tropics under a vertical sun would probably not rise above freezing point.

"The temperature of the earth's surface," he wrote, ... "and with it the existence not only of the human race, but of all organized life on the globe, appears in the light of the conclusions reached by the Mount Whitney expedition to depend far less on the direct solar heat than on the hitherto little regarded quality of selective absorption in our atmosphere."

The bearing of these observations on such questions as the temperature of the sun and the radiation from the sky is

manifestly very important. The extent of the solar spectrum previously known was but a fraction of that discovered by this expedition.[1]

Mr. Langley's determination of the power of the sun's light and heat, as made at Pittsburg in 1878, is one based upon definite standards of comparison. He then demonstrated that the sun's disk radiates fifty-three hundred times as much light, and eighty-seven times as much heat, as would an equal area of metal in the converter of a Bessemer furnace in full blast.

Of Mr. Langley's numerous subsequent investigations with the bolometer, there can only be mentioned his researches on the temperature of the moon, which entirely changed the conclusions previously held from the statements of Sir John Herschel and the experiments of Lord Rosse, and his measures of the amount of energy realized in the form of light by different natural and artificial methods of producing it.

Extremely significant in this latter respect were his observations made in Washington upon the spectrum of the firefly, *Pyrophorus noctilucus.* He showed that its radiation consists wholly of visible radiations, or, in other words, that there exists in use a natural process by which all the heat generated is converted into light, a process probably imitable, and which if successfully imitated would be of immense industrial importance. In the gas flame only two per cent. of the heat is utilized in visible radiation and ninety-eight per cent. is wasted.

Within comparatively few years Mr. Langley has taken up the study of the physics of the atmosphere and the conditions of artificial flight. This is a subject in which he has been interested from boyhood, though it was not until 1889 that he

[1] In this connection reference should be made to the work of J. E. Keeler, one of his students, and his successor as director of the Allegheny Observatory, upon the influence of absorption of certain rays in the visible spectrum by the carbon dioxide of the atmosphere.

began serious work. Many of these investigations have been carried on at the Smithsonian Institution, although some of the earlier elaborate experiments with the whirling table were carried on at the Allegheny Observatory.

V.

In 1891 he published his now famous paper entitled "Experiments in Aërodynamics," in which he first made public the results of his studies upon this subject. This paper threw new light on the motion of certain forms of bodies through the atmosphere, and resulted in a practical revolution in the conclusions drawn from the study of aërodynamics. His paper on "The Internal Work of the Wind," presented to the International Conference on Aërial Navigation, held in Chicago, in 1893, made even a greater impression, especially upon the minds of those engaged practically upon the problem of artificial flight. The importance of the views then for the first time advanced was universally admitted, as is evident from two recent authoritative general works on the subject of aërial navigation, those of Mr. Octave Chanute, of Chicago, and Doctor von Salverda, of Holland. In March, 1894, Lieutenant-Colonel Elsdale, of the Royal Engineers, in an article in the *Contemporary Review*, wrote:

"Professor Langley may fairly be said to have laid down, for the first time, a really sound and reliable scientific basis for the study of aërial locomotion, by a series of careful experiments and well-reasoned deductions from them. Whatever its ultimate measure of success is, new experiments with it cannot fail to advance the cause of aërial navigation another stage."

To a letter of inquiry in regard to the significance of these contributions to the science of aërodynamics, Mr. Octave

Chanute, of Chicago, responded to the writer, April 10, 1896, as follows:

"In my judgment the principal contributions thus far made by Doctor Langley to the science of Aërodynamics consist in his having given to physicists and searchers firm ground to stand upon concerning the fundamental and much-disputed question of air resistances and reaction.

"When I was in Europe in 1889, I inquired into the state of knowledge on this important question, and found utter disagreement and confusion. There were numerous formulæ, promoted by various physicists, but these gave such discordant results that arrangements were being proposed in France to try an entire set of new experiments, with air currents to be procured by an enormous fan-blower. A fair idea of the state of knowledge can be had from Professor Marey's careful work on "Le vol des oiseaux," published in 1890. Oblique pressures were then still generally held to vary according to the Newtonian law, or as the square of the sine of incidence, although this gives but five to ten per cent. of the true reactions at acute angles of incidence.

"Doctor Langley has shown us, by experiment, the general accuracy of which cannot be questioned, that the empirical (based on experiments) formula of Duchemin is sufficiently correct to calculate the radiations upon planes; so that the French, who had ignored this formula since 1836, now claim its inception and accept it (as they do some wines) *retour d'Amérique.* Doctor Langley has also shown us that the variation of the center of pressure on an inclined plane, observed by Sir George Cayley and by Avanzani as well as by Kummer, follows approximately the law formulated by Jossel, so that now, for the first time, searchers are enabled to calculate the sustaining power, the resistance, and the center of pressure of a plane, with confidence that they are not far wrong; and this, together with the further law, formulated first by Doctor Langley, that within certain limits 'the higher speeds are more economical of power than the lower ones,' has made it possible to assert that the problem of artificial flight is not in-

soluble as theretofore affirmed by many of the most eminent scientific men.

"Whether Doctor Langley's scientific labors in this department of physics will soon result, like those of the preceding Secretaries, in the practical application of his discoveries to the use of mankind, it is perhaps too early to assert positively. I think, myself, that they will so result before many years, but there are so many intricate questions to be solved before commercial success can be achieved that another generation may pass before the problem of flight is fully solved.

"Moreover, Doctor Langley's labors and discoveries are by no means over. He has thus far published only the result of his investigations on planes, while saying in the penultimate paragraph of his summary that it is not asserted that planes are the best forms to use. Lilienthal and Phillips have since shown that concave-convex surfaces are more efficient forms, and it is very much to be desired that Doctor Langley shall next publish some data concerning such forms.

"The practical development of a scientific truth is somewhat like the growth from a new seed. We recognize the existence of the plant, we ascertain some of its virtues; but we cannot tell its full uses, how soon it will mature, nor how large the tree will be.

"It is significant, however, that, prior to the publication of Doctor Langley's work, it was the rare exception to find engineers and scientists of recognized ability who would fully admit *the possibility* of man being able to solve the twenty-century old problem of aviation. Professor Joseph Le Conte, in the *Popular Science Monthly* of November, 1888, has very recently taken the ground, flatly, 'that a pure flying machine is impossible.' This was probably based on the fact that the then accepted formula of Newton, and the calculation of Napier and other scientists, if correct, rendered the solution practically impossible. Since the publication of 'Experiments in Aërodynamics,' however, it is the exception to find an intelligent engineer who disputes the *probability* of the eventual solution of the problem of man-flight. Such has been the

change in five years. Incredulity has given way, interest has been aroused in the scientific question, a sound basis has been furnished for experiment, and practical results are being evolved by many workers. Much remains to be discovered concerning curved surfaces, with which alone practical flight is likely to be achieved, but when this is accomplished it is probable, in my judgment, that the beginning of the solution will be acknowledged to date back to the publication of Doctor Langley's book, and that he will be distinguished as Secretary Henry is now with regard to the development of electrical appliances."

In the brief interval between the date of the letter just quoted and the sending of this sketch to the printer, an aërodrome, constructed by Mr. Langley, has made two successful flights, each to a distance of rather more than half a mile, practically demonstrating the correctness of the principles which it has been seen were generally accepted, on theoretical grounds, as soon as they were made public.[1]

[1] A description of these flights, which took place on May 6, 1896, was communicated to the *Comptes Rendus* of the French Academy of Sciences, by Professor Alexander Graham Bell, who was an eye witness, and an English translation of the same is contained in *Nature*, Volume LIV, page 80.

Professor Bell states that two ascensions were made by the aërodrome which was built almost entirely of metal, and driven by a steam engine of extraordinary lightness, the absolute weight of the aërodrome, including the engine and all its appurtenances, being about twenty-five pounds, and the method of propulsion by aërial propellers, without any gas or other aid for lifting it in the air, except its own internal energy.

"On the occasion referred to," says Professor Bell, "the aërodrome, at a given signal, started from a platform about twenty feet above the water, and rose at first directly in the face of the wind, moving at all times with remarkable steadiness, and continually ascending until its steam was exhausted, when, at a height I judged to be between eighty and one hundred feet in the air, the wheels ceased turning, and the machine, deprived of the aid of its propellers, to my surprise, did not fall, but settled down gently, and without the least shock, and was immediately ready for another trial.

"In the second trial, which followed directly, it repeated in nearly every respect the actions of the first, except that the direction of its course was different. It ascended again in the face of the wind. I estimated that the actual length of flight on each occasion was slightly over three thousand feet. It is at least safe to say that each exceeded half an English mile."

He continues: "I cannot but add that it seems to me that no one who was present on this interesting occasion could have failed to recognize that the practicability of mechanical flight had been demonstrated."

A third and still longer flight was made on November 28, 1896, with another machine built of steel like the first, and driven like that by propellers actuated by a steam engine of between one and two horse power, making a horizontal flight of over three-quarters of a mile, and descending in safety.

The significance of these experiments is summed up by a recent writer as follows:

"In both its matter and manner, Professor Langley's invention, or discovery, is of unique interest. His machine is built upon exactly the opposite principle from that upon which other flying machines have been built, and his invention represents a clear triumph for pure inductive science.

"When Stephenson built his locomotive he proceeded in his work upon certain definitely known facts; that is, he was perfectly sure that if he could find a way to push his wheels around by steam, his engine could run over the ground just as an ordinary wagon would. He was venturing into no unknown field of physics. With Professor Langley it was just the opposite. Although men of science for two centuries or more have been studying the dynamics of the air, have weighed it and determined its compressibility, its action under heat, etc., yet up to the time Professor Langley took hold of the matter there existed no definite data as to the plan or principle upon which a flying machine, if it is to successfully navigate the air, must be built. To find out these new data was his first work.

"Put in a less technical way, Professor Langley's problem was this: He says, 'Did you ever think what a physical miracle it is for such a bird as one of our common turkey buzzards to fly in the way it does? You may see them any day along the Potomac, floating in the air, with hardly a movement of their feathers. These birds weigh from five to ten pounds; they are far heavier than the air they displace; they are absolutely heavier than so many flatirons.

"'I fancy if you saw cannon-balls floating through the air like soap-bubbles you would look upon it as a sufficiently surprising matter, if not as a miracle. The only reason that we are not surprised at the soaring bird is that we have seen it from childhood. Perhaps if we had seen cannon-balls floating in the air from our childhood we would not stop to inquire how they did it, any more than we now do how the turkey buzzard does it. I am speaking now, of course, not of birds

that fly by flapping their wings, but of those that fly without flapping their wings, and with almost no visible expenditure of force.'

"It was from watching the soaring birds that Professor Langley came to conclude that it was possible to build solid models very much heavier than the air and drive and direct such a machine with such an ordinary force as steam. That is to say, he became convinced that there are certain shapes in which matter can be disposed so that the more rapidly it moves through the air, in a sense, the less power it takes to move it, and that a machine could be built to skim through the air very much as a skater skims along the surface of very thin ice — the faster you go the less danger.

"Professor Langley believed that soaring birds have an intuitive knowledge of certain properties in the air by which they are able to skim along — rising and falling, soaring up and sailing down, and turning about in circles without any flapping of their wings or apparently any other effort. Just what these properties were he attempted to find out and develop by experiment.

"Well, the upshot of the matter was that from these experiments it was demonstrated that a machine, not a balloon, can be made which will produce enough mechanical power to support itself in the air and fly. 'Though,' Professor Langley adds, 'this is not saying that we have got skill enough to manage this power so as to rise and fly about in the air and descend safely.' What is actually demonstrated, repeated hundreds of times in the laboratory, and, finally, with the successful machine which Professor Langley built, is that the flying machine is possible. All that now remains is to perfect it and learn how to manage it.

"The experiments which Professor Langley carried on resulted in showing that an expenditure of one horse-power, in horizontal flight, will support about 200 pounds, and at the same time carry this burden at a rate of fifty miles an hour through the air. Now, there have recently been built steam engines which, with fuel and water for a short flight, weigh a good deal less than twenty pounds. The relative weight of

an engine decreases with the number of its horse-power, so that there seems no reason to doubt that what Professor Langley has done on a small scale may be done on a large one, and very shortly at that.

"Professor Langley's machine measures but fourteen feet from tip to tip; weighs, complete, twenty-four pounds, is solidly built of steel, and, compared with the air which supports it, has a weight of a thousand to one. It has no balloon arrangements of any sort, and instead of trying to build a vessel lighter than the air and filling it with gases to make it rise, Professor Langley has practically built a machine as heavy as he likes and relied upon its shape and power for successful flight.

"This is just the opposite of what almost every other experimenter in this field has tried to do, although it was apparent to every one that a flying machine, to be of any commercial or practical value whatever, would have to be heavy enough and powerful enough to drive straight against or across and in and out of the stoutest gale that blows. Otherwise it would forever be at the mercy of the element. What was necessary was a ship that would ride a storm in the air as a great ocean liner rides a storm at sea.

"Professor Langley has been very careful to say that he never expressed his opinion that man could fly of his own strength. But he has demonstrated that powerful machines thousands of times as heavy as the air itself can be built to navigate the air."

VI.

CONCERNING the administrative side of Secretary Langley's work during the past ten years, it seems scarcely necessary to speak at length in this place. The story told by this volume, at the end of his first ten years of service, is ample evidence that the efficiency of the Smithsonian organization has not diminished while under his charge, and that the care of this, rather than of his scientific pursuits, has occupied the

greater portion of his time and thought during the period of his incumbency.

No one can ever make so strong an impression upon the character of an institution as he to whom the task of organizing it is intrusted. It is manifestly impossible that his successors should be able to modify materially the policy of an institution which has been organized for a definite purpose and by the hands of a person whose judgment and ability they hold in respect. Their work, however, is none the less important in that it is conservative rather than entirely constructive. Their task is to maintain the efficiency of the organization and to keep it abreast of the times. They must be alert to appreciate the demands which arise from changed conditions and secure the means for a growth which shall not only be constant but symmetrical.

The history of the Institution bears evidence that it has been under the constant control of men of unusual ability, energy, and personal influence. No boards of trustees, or regents, no succession of officers serving out their terms in rotation, could possibly have developed from a chaos of conflicting opinions a strongly individualized establishment like the Smithsonian Institution.

The names of the first two Secretaries are so thoroughly identified with the history of the Institution, by reason of their constant connection with it during its first four decades, that their biographies together could form almost a complete history of its operations. The period during which the third Secretary has served is of comparatively less length, yet of great importance from the fact that he has done so much to render permanent the work which his predecessors began.

Each of the three, in addition to his general administrative work, has made some features of the general plan peculiarly his own. Secretary Henry gave especial attention to the

publications, the system of international exchanges, and the development of that great system of meteorological observations, the storm predictions, which has since become the Weather Bureau.

Secretary Baird continued the development of the Museum, which had been under his special charge during the twenty-seven years of his service as Assistant Secretary, secured the erection of the Museum building, gave much attention to zoölogical and ethnological exploration, and, in connection with his special work as Commissioner of Fisheries, secured the construction of the exploring ship *Albatross*, and carried on extensive investigations in American waters. In addition to his Smithsonian work he will always be remembered as one of the greatest of naturalists, the founder of the United States Fish Commission and of "public fish-culture."

Under the administration of Secretary Langley there has been renewed activity in the library and exchange work, and a new system has been introduced for the encouragement of original research in physical and biological science. During his administration important donations and bequests have been added to the permanent fund of the Institution. The limit of one million dollars which may by law be deposited in the United States Treasury, at six per cent., has nearly been reached, and Congress has recognized the authority of the Institution to receive and administer other funds beyond this limit, thus making it possible for it to undertake the administration of financial trusts for any purpose within the scope of its general plan.

Secretary Langley will always be remembered as the founder of the Smithsonian Astrophysical Observatory and of the National Zoölogical Park, in which his assiduous personal labor was largely instrumental in securing to the nation the most picturesque, and up to this time the largest, tract of

land in the world devoted to such uses. His contributions to science during his Secretaryship will also always be associated with his career at the Smithsonian, though they have been necessarily subordinated to administrative duties which are the principal occupation of the Secretary.

VII.

Mr. Langley's contributions to science have been numerous. They have been published in the transactions of various learned societies and in the scientific journals, especially the *Comptes Rendus* of the French Academy of Sciences and the *American Journal of Science.*

He published a series of articles in *The Century Magazine* in 1884 and 1886 upon astrophysical research, based upon a series of lectures delivered by him at the Lowell Institute in Boston in 1883. These articles have since been republished under the title of "The New Astronomy," which is one of the most successful of modern scientific books written in popular style.

Mr. Langley is a correspondent of the French Institute (in the Academy of Sciences), a foreign member of the Royal Society of London, a Fellow of the Royal Astronomical Society of London, a member of the National Academy of Sciences, and of numerous other foreign and American scientific bodies. In 1878 he was made Vice-President of Section A of the American Association for the Advancement of Science, and in 1886 was elected President of that association, delivering the presidential address at the Cleveland meeting in 1888, entitled the "History of a Doctrine." He has received numerous degrees from universities, among them that of LL. D. from the University of Wisconsin in 1882, the University of Michigan in 1883, from Harvard University in 1886, and

Princeton University in 1896; and in 1894 that of D. C. L. from the University of Oxford. He was the first to receive, in 1886, the Henry Draper medal of the National Academy of Sciences for work in astronomical physics. In 1887 he was awarded the Rumford medal by the Royal Society of London, and the Rumford gold and silver medals by the American Academy of Arts and Sciences. It seems especially fit that the American who has in this century been most eminent as a student of the laws of heat should thus come into possession of the two memorials, American and English, of the great American who in the last century made such important contributions to the same branch of science.

More than all these formal honors, by far, is the worldwide recognition of his achievements in the formulation of the principles of aërodynamics and the discovery of so much of the solar spectrum.

THE BENEFACTORS

By Samuel Pierpont Langley

THE original bequest of James Smithson, together with the accrued interest and savings, constituted a fund of over seven hundred thousand dollars. The sum now placed to the credit of the Smithsonian deposit in the Treasury of the United States, together with some securities undeposited, lacks but little of a million, about one quarter of a million of dollars having been added to the original fund in the past five years.

The addition has been made by several benefactors who have recognized, as years go on, the ever-increasing ability of the Institution to act as trustee for the funds whose givers have aims in consonance with those of the founder.

I shall briefly sketch the biography of these men who have given of their means to promote the usefulness of the Smithsonian Institution, and who have expressed their confidence in the policy and permanency of the Institution by making it their trustee in carrying out their design for the increase and diffusion of knowledge among men. Before passing to these, however, the fact should be recalled that the earliest addition to the Smithson fund came from the first Secretary, Joseph

Henry. In the year 1847 Professor Henry was invited to deliver a course of lectures in Princeton, the college of whose faculty he had been a member prior to his acceptance of the chief executive office of the newly-founded Institution. Princeton University,— or the College of New Jersey, as it was then known,—paid him for this course of lectures an honorarium of $1000, which Professor Henry placed to the credit of the Board of Regents.

In 1874 a bequest of $1000 was received from the estate of James Hamilton, "the interest to be appropriated biennially by the Secretaries, either in money or a medal, for such contribution, paper, or lecture on any scientific or useful subject as said Secretaries may direct."

Mr. Hamilton was born in Carlisle, Pennsylvania, October 16, 1793, and died there January 23, 1873. He was graduated from Dickinson College in 1812, and was admitted to the Bar in 1816. For a few years he followed the practice of his profession, and then retired to devote himself to the more congenial pursuits of science and literature. He was a close student of astronomy, botany, and mineralogy, and his interest also extended to education, for he was a trustee of Dickinson College in 1824–'33, and was almost continuously a school director in Carlisle from the inception of the school system there in 1836, till his death. His philanthropy and public spirit showed itself in many ways. Not only was he one of the organizers and trustees of the Presbyterian Church, but he was also active in its work as well. His charities were numerous and his will included more than a thousand items of benefaction.

In 1879 a bequest of $402.59 was received from Doctor Simeon Habel. This sum was increased from the income

of the Institution to $500, and placed to the credit of the Smithsonian fund.

Doctor Habel was of Austrian birth and was graduated at the University of Vienna in 1846. He came to America and undertook an extended tour through Central and South America. Before doing this he spent several months at the Institution familiarizing himself with the work of the Geological Department. In 1877 he prepared a memoir for the Institution entitled "The Sculptures of Santa Lucia Cosumalwhuapa, in Guatemala, with an account of Travels in Central America and on the Western Coast of South America," which was published in the "Smithsonian Contributions to Knowledge."

In 1889 a bequest of $5000 was received from Doctor Kidder, to be used for the promotion of physical research.

Doctor Jerome Henry Kidder was born in Baltimore County, Maryland, on October 26, 1842, and was graduated in 1862 at Harvard University, where he is still remembered as foremost in the gymnasium as well as on his class-rolls. He immediately tendered his services for the Civil War, and was placed in charge of the sea-island plantations near Beaufort, South Carolina, where he contracted yellow fever, and was sent home early in 1863; but upon recovery he enlisted in the Tenth Maryland Infantry, in which he served as private and non-commissioned officer until the following year, when he was selected to be medical cadet, and in that capacity was employed in the military hospitals near the capital. During this time he was prosecuting the study of medicine, and in 1866 received from the University of Maryland the degree of M. D. In the same year he was commissioned an assistant surgeon in the United States Navy, becoming full surgeon in the month of May, 1876.

Doctor Kidder's first duty was in Philadelphia. After a year he went to Japan, where he quickly acquired the language of the country, and in other ways established the reputation which attached to him throughout his career for his "capacity for taking pains." While on this foreign service he was decorated by the King of Portugal in recognition of services to a distressed vessel of his Majesty's navy.

Doctor Kidder took part in observing the transit of Venus at Kerguelen Island, in 1874, as surgeon and naturalist of the expedition, and the excellent results of his scientific labors and researches therewith were described in bulletins of the United States National Museum. After the return of this expedition, Doctor Kidder arranged his specimens and collections in the Smithsonian Institution, and began those kindly and intimate relations with it which continued through the remainder of his life.

In 1878 Doctor Kidder married, in Constantinople, Annie Mary, daughter of the Honorable Horace Maynard, Minister of the United States to Turkey, and in 1884, having inherited an adequate fortune, he resigned his commission and established his home in Washington, and organized the bacteriological laboratory in connection with the Navy Museum of Hygiene, and also made a sanitary survey of the site proposed for the Naval Observatory. Later he was appointed chemist of the United States Fish Commission, and in that capacity became one of the most trusted advisers of Professor Baird. His laboratory was in the Smithsonian building; and, under the direction of the Secretary of the Institution he made, at the request of Congress, an exhaustive study of the ventilation of the Capitol and of the air in the Senate chambers and the hall of the House, and submitted an extended report for the use of the committees engaged upon the sanitary reform of the building. In 1887, after the death

of Commissioner Baird, he served for a time as Assistant Commissioner of Fisheries, under Commissioner Goode. While connected with the Fish Commission he carried on a successful series of experiments to solve the problems relative to the temperature of living fishes, which have been made public through the reports of the Fish Commission. Besides the reports just referred to, Doctor Kidder contributed valuable papers to various professional and educational publications, and held for years a place on the literary staff of the New York *World*, and maintained membership in many learned societies. He was one of the founders of the Cosmos Club, one of the organizers of the Harvard Club in Washington, and a prominent member in the Masonic fraternity.

In 1888 Doctor Kidder accepted the appointment of curator of laboratory and exchanges; and the writer cannot speak in too warm terms of the character of Doctor Kidder as shown in their business relations. His liberal education and views, served by the "capacity for taking pains" already referred to, were all under the control of the most conscientious regard for duty, and made him a valued administrator of the department under his charge. He knew how to maintain, together with exact order, the kindliest relations with all employed in it, who, it is safe to say, remember him with an affection and regard due to his excellent personal qualities, a feeling which the writer profoundly shares. Just in his best work, in his fullest physical vigor, Doctor Kidder was stricken with pneumonia, and died after a brief illness in Washington on April 8, 1889.

He was a man most worthy of trust in every relation of life, and deeply mourned by those who enjoyed his friendship.

In 1891 Alexander Graham Bell presented to me $5000 to aid in scientific researches I was carrying on, which sum was,

with his consent, placed under the general charge of the Institution, where it has been employed for objects cognate with those contemplated by the donor.

The present brief notice of Doctor Bell would have been a fuller one were it not that a reluctance to be the object of public notice has made it difficult to find the necessary facts for the biographer.

We know of his life little more than that he was born in Edinburgh, Scotland, on March 3, 1847; that he is understood to have been educated in London and Edinburgh; that in 1870 he removed to Canada, and that in 1872 he settled in Boston, where he introduced the system of visible speech invented by his father, which was especially for the benefit of the deaf and dumb, and where he became professor of vocal physiology in the Boston University.

At this time the transmission of sound by electricity attracted his attention, and he made the invention which brought him his present great and deserved fame. It was at the Centennial Exhibition held in Philadelphia in 1876 that the telephone was first exhibited. It attracted the immediate notice of Sir William Thomson (now Lord Kelvin), and other eminent electricians, and almost at once it engrossed the attention of the public, and the news of the discovery spread over the civilized world.

Doctor Bell's scientific work was by no means confined to the telephone, although it is in connection with that invention that his name is best known. He has added various devices connected with the transmission of speech by electricity, among which is that described by Antoine Breguet in the *Comptes Rendus* of the French Academy of Sciences of 1880.[1]

Doctor Bell, among other rewards of his invention of the telephone, received the Volta prize of fifty thousand francs

[1] Volume XCI, pages 595 and 652.

from the Institute of France in 1880, and with this and considerable additions, he founded in 1883 the Volta Bureau, and erected a building in Georgetown, where it is installed. It includes a library and facilities for investigations into the condition of the deaf and dumb, in which subject Doctor Bell has always continued to take a deep interest.

In his adopted country, Doctor Bell's contributions to science have been recognized by an election, in 1883, to the National Academy of Sciences, and the recent conferment of the degree of LL.D., while the decoration of the Legion of Honor has been received by him from the French government.

In 1891 Thomas George Hodgkins gave $200,000 to the Smithsonian Institution, stipulating that while that sum should be included with the original Smithson Foundation, the income of one-half of it should be devoted to researches and investigations on atmospheric air in connection with the welfare of man. Subsequent to his death an additional sum of nearly $50,000 was received by the Institution from his estate, making the total gift one of about a quarter of a million dollars.

Mr. Hodgkins was born in London, England, in 1803, and died in Setauket, Long Island, on November 25, 1892. His ancestors were clergymen, and belonged to the class of English gentlemen, but his father, who was in reduced circumstances, was unable to keep him at Eton or Harrow, and sent him to France, where he remained for his education until he was about fifteen years old. During this time his language, habits, and manners, became rather French than English.

He returned to England; but troubles with a stepmother made his home unbearable, and, against the urgent entreaty

of his father, he shipped before the mast in a trading vessel bound for Calcutta. The vessel was wrecked near the mouth of the Hoogly, and young Hodgkins found himself penniless and friendless in Calcutta, where he was taken ill and carried to the hospital. He has since said that it was here, while he was a sick lad, and was told that he had not six months to live, that he made up his mind that he would live, that he would acquire a fortune, and that he would devote it to large and philanthropic ends.

He recovered sufficiently to prepare a petition to the Governor-General of India, who was then the Marquis of Hastings, asking for aid to return to England; and he walked a long distance into the country, where the Governor-General was staying at his country-seat, to deliver it. He arrived at the viceregal residence barefooted and ill-clad, and asked an audience with the ruler of India with such persistence that the attendants, who at first refused, finally consented to present his petition. This so impressed the Viceroy when he read it that he directed that the young sailor should be admitted to see him, and the interview that followed ended by his offering young Hodgkins a position in his household which any gentleman's son might have been willing to accept, but which he refused from his overmastering wish to return to his father.

I think this curious adventure (as it may almost be called) deserves narration as an instance both of the remarkable force of Mr. Hodgkins's character and of the evidence of gentle breeding his manners always bore, and of the influence both had on others even in his earliest years.

After going home he went to Spain; later, returning to England, he married, and in 1830 came to this country. He immediately engaged in business, which he pursued with unremitting energy for thirty years, when he retired on what was

at that time considered a handsome fortune. The fifteen years following this he spent in traveling over Europe and America, and finally in 1875 he settled down in Setauket, Long Island, upon his place "Brambletye Farm," which he rarely left, except for an occasional visit to New York City, until his death.

Mr. Hodgkins was a man of remarkably self-poised mind, singularly independent in his modes of thought, and independent also of the need of social converse or of adventitious interests. His opinions were his own, and he found in the reading which confirmed them and in the care of his little farm abundant and agreeable occupation for the leisure of his declining years.

He was a man of keen intelligence, and by nature, perhaps, still more a thinker and a scholar than a man of affairs, though even in the latter capacity his ability was proven by his success in business. He possessed a strong will, and had deliberately formed and tenaciously held opinions of his own in relation to religious and philosophical questions. In regard to the former, it may be sufficient to say that his mind was of a devout cast, and that while he had thought much for himself, he retained to the last an absolute trust in the divine guidance as the leading motive of his life.

Mr. Hodgkins had for more than thirty years made a special study of the atmosphere in its relations to the well-being of humanity. He believed that most of the physical evils to which mankind are subject arise from the vitiation of the air which they breathe, and that the study of the atmosphere is not unimportant even with relation to man's moral and spiritual, as well as his physical health; and though he did not point out any line of investigation likely to bear fruit in the latter direction, it was his hope that the concentration of thought upon the atmosphere and its study from every point

of view would in time lead to results which would justify his almost devout interest in the subject.

He was very explicit in his statements that it was not for sanitary science or for meteorology, or for the like branches of study alone, or for those which might seem most obviously suggested by the words of his trust, to profit exclusively by it, for he believed that every department of philosophy (using the term in its widest sense) would be found to be finally connected with every other, through this common bond of union; so that it was his particular desire to have such varied investigations in the atmosphere made as would aid in the enlargement of each and all of these aspects of knowledge.

Mr. Hodgkins brought to all his studies, as to this, a very retentive memory, while general reading and travel had stored his mind with singularly varied information. He was a good French scholar and loved to quote from the French classics. His catholicity of mind was sufficient to include a not inconsiderable sense of humor, and his favorite quotation from Boileau pointed to his consciousness of a perhaps too imaginative indulgence in his favorite themes. He was a punctilious correspondent, and what it is not too much to call his real literary ability was never shown more happily than in his letters, which were in many respects models of epistolary ease, and even of charm of diction. He was hospitable and enjoyed entertaining the few friends whom he admitted to his table, where his manner, as a host of the old school, was a happy one.

Mr. Hodgkins had no family and no known blood relations, and, recognizing the difficulties which often arise over the settlements of large estates, he chose to be his own executor rather than leave the disposition of his affairs to those who might either misinterpret or disregard his requests when he could no longer appear as a witness in his own behalf. He,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therefore, gave away his entire estate, amounting to about half a million dollars, to various public institutions.

His funeral was unostentatious, as he requested it should be, only his intimate friends attending. Among these I was numbered; for while I felt it an official duty to represent this Institution at the funeral of one to whom it owed so much, I was there also from a feeling of real friendship and regard to an old man whose singular powers, whose lonely life, and whose — perhaps often unmet — affection had drawn me to him as to a personal friend.[1]

In 1894 a bequest was received from Robert Stanton Avery, consisting of almost all of his small estate, to establish "the fund constituted by Robert S. Avery and his wife Lydia T. Avery for the extension of the sciences."

Robert Stanton Avery was born near Preston, Connecticut, May 1, 1808; and died in Washington City, September 12, 1894. After spending nearly fifteen years in teaching and studying, he entered Harvard Divinity School and was graduated in 1846. Failing health prevented his acceptance of a pastoral charge, and while settling up his father's estate he began the study of the mathematics and their application to

[1] The Secretary of the Smithsonian Institution issued a circular on March 31, 1893, announcing a series of prizes for contributions to knowledge in regard to the nature or properties of atmospheric air. The same circular announced the establishment of a medal to be known as "The Hodgkins Medal of the Smithsonian Institution," to be awarded "for important contributions to our knowledge of the nature and properties of atmospheric air or for practical applications of our existing knowledge of them to the welfare of mankind." The medal itself — the obverse and reverse of which are shown in the accompanying illustration — was designed by Monsieur J. C. Chaplain, of Paris, a member of the French Academy and one of the most eminent medalists in the world. It bears on its obverse a female figure carrying a torch in her left hand, and in her right a scroll emblematic of knowledge and the words "*Per Orbem*," while the reverse is adapted from the seal of the Institution as designed by Augustus St. Gaudens, the map of the world being replaced by the words "Hodgkins Medal." No impression of the Hodgkins medal in gold has as yet been awarded, but four impressions in silver and eight in bronze were awarded to successful competitors for the Hodgkins prizes. In future the medal will be awarded from time to time as some grand scientific discovery is made that is worthy of such recognition. The medals were struck at the French Mint in Paris, and are seven and a half centimeters in diameter (about three inches), and the gold medal was to have had a bullion value of $240 to $300.

the physical sciences. In 1853 he received an appointment in the Coast Survey, and was assigned to the reduction and compilation of tide-tables, becoming after several promotions chief of the tidal division of the Survey, which place he held until 1885, when he resigned. Subsequently he devoted himself to the preparation of school-books designed to extend the teaching and use of phonetic spelling.

Mr. Avery's property lay chiefly in real estate in Washington, which has still to be disposed of, and his bequest has not yet become effective. He has indicated a wish that it may be employed partly in researches connected with the ether, as well as in the printing of some mathematical tables.

THE SMITHSONIAN BUILDING AND GROUNDS

By George Brown Goode

THAT the Smithsonian Institution, before it could begin active operations, must have a home of its own would doubtless have been regarded as a necessity by any one considering the requirements of the future. Richard Rush, however, appears to have been the first to state this idea in words, which he did in a letter addressed November 6, 1838, to the Secretary of State, in response to a request of the President for suggestions in regard to the proper manner of carrying out the bequest.

In the bill prepared by John Quincy Adams, and presented February 18, 1839, it was provided that the observatory, which was to be the first of the Smithsonian buildings, should be erected, under the direction of the Secretary of the Treasury, upon land belonging to the United States, which, after its selection, should be granted for the purpose and conveyed as a deed of gift to the trustees of the Smithsonian fund. In those days the locality known as Camp Hill, near the banks of the Potomac, opposite Analostan Island, near the mouth of Rock Creek, seems to have been under consid-

eration. This site was the one which was designated by Washington for the National University, and reserved for that purpose upon the original plan of the city. It was subsequently used for the purpose Mr. Adams had in mind, namely, as the site of the United States Naval Observatory, a building for which was erected upon it in 1843–'44, and occupied until 1893, when a group of finer structures were built upon Georgetown Heights.

In another bill, introduced by Lewis F. Linn into the Senate February 10, 1841, the whole of the tract known as the Mall was appropriated for the uses of the Smithsonian Institution, with the provision that the buildings should be erected in accordance with the plans prepared by and under the supervision of the National Institution, to be approved by the President of the United States.

In bills introduced into the Senate in June and December, 1844, by the Library committee,— Rufus Choate, Benjamin Tappan, and James McP. Berrien,— appeared the first definite characterization of the building, which was to be plain and durable, without unnecessary ornament, and to contain provisions for cabinets of natural history and geology, and for a library, a chemical laboratory, and lecture-rooms. This building was to be placed upon a site to be selected in that portion of the Mall lying west of Seventh Street. The cost was at that time limited to eighty thousand dollars. In 1846, however, the bill of Doctor Robert Dale Owen, without change of phraseology from those which had preceded it in regard to location and character of the structure, was adopted, but the limit of the cost was increased, and $242,-129, the exact amount of the Smithsonian interest which had at that time accrued, "together with any additional interest which might remain after paying the current expenses of the succeeding years," was designated for that purpose.

After the present site had been selected, there appears to have been some dissatisfaction in regard to it; nor is this to be wondered at, since at that time the Mall was remote from the inhabited portion of the city, being a part of what was then known as "The Island," now called South Washington. This portion of the city was cut off by an old and unsightly canal, running to the Potomac, and crossed by simple wooden bridges at four points between the Capitol and the Potomac River. It was unfenced and waste, occupied from time to time by military encampments and by traveling showmen. After the completion of the east wing in 1850, when the first lectures were held in the Institution, the Regents were obliged to build plank walks for the accommodation of visitors. Indeed, with the exception of the Capitol grounds and those surrounding the Executive Mansion, the open places in the city were entirely unimproved.

Soon after the selection of the present site, the question was reconsidered by the Board, and a committee appointed to obtain, if possible, another location. In the bill as it finally passed Congress, permission had been given to locate the building on the space between the Patent Office and Seventh Street, now occupied by the building used for the offices of the Interior Department. This was partly to enable the Institution to utilize for its collections the large hall in the Patent Office then assigned to the "National Cabinet of Curiosities," partly, no doubt, to secure a more central location. To obtain this ground, however, it was necessary to have the approval of the President of the United States and other public officials, which was not found practicable. The Committee fixed upon Judiciary Square, an open space of rough ground, in which at that time the City Hall (a portion of the present structure), the Infirmary, and the City Jail were located. Though the adjoining streets were entirely

vacant, this site was regarded as much more accessible than the Mall.

A proposition was submitted to the Common Council of the City of Washington, that the site of the City Hall should be resigned for the use of the Smithsonian Institution upon its offering to pay to the city $50,000, a sum deemed sufficient to erect a building for the use of the city government upon the site south of Pennsylvania Avenue, between Seventh and Ninth streets, now occupied by the Center Market. A bill was introduced into Congress, authorizing the Regents to purchase the City Hall, but the Common Council refused to consider the proposition, and the site of the Mall was used.

From the very beginning Doctor Owen was the chief advocate of a large and showy building. In this matter he was supported by the sympathy of the people of Washington, and especially Mr. William W. Seaton, Mayor of the city and one of the Regents, whose interest in the realization of the plan of Smithson undoubtedly did much at last to secure action from Congress. Outside of Washington, there was much opposition to an expensive building, owing partly to the manner in which the bequest of Stephen Girard had been rendered for many years inoperative by the action of its trustees.

Doctor Owen himself was earnest in his denunciation of such abuses. "Of the noble Girard fund," said he, "three quarters of a million of dollars are lost forever, and though half a generation has passed away since the eccentric Philadelphian died, not one child has yet reaped the benefit of his munificent bequest. A temple has, indeed, arisen that outshines Greece and her Parthenon ; its sumptuous Corinthian pillars, each one costing a sum that would have endowed a professorship, are the admiration of beholders and the boast

of the Quaker City; but years must yet elapse before the first son of indigence can ascend the steps of that princely portico and sit down within those marble halls to receive the education for which its simple and unostentatious founder sought to provide."

Doctor Owen, nevertheless, more than any other person at that time concerned in the establishment of the Institution, seems to have felt that much of its future success depended upon the erection of a building which should perform a legitimate duty in dignifying and making conspicuous the work of the organization to which it belonged. Scarcely any one can doubt that Doctor Owen was right and that the usefulness of the Smithsonian Institution has been materially aided by the fact that its building has for fifty years been one of the chief architectural ornaments of the national capital.

The first act of the Regents, after appointing the committees on organization and library, was to instruct the Chancellor, Secretary, and Executive committee to obtain plans for the erection of buildings. Doctor Owen, Mr. Hough, and General Totten, on behalf of this committee, visited several of the principal cities, examined their prominent public buildings, and conferred with several architects. At a meeting on November 30, 1846, they reported that out of thirteen plans submitted to them they had unanimously selected two, by Mr. James Renwick, Jr., of New York City, one in the decorative Gothic style, the other in Norman, or Lombard; the latter was recommended as being simpler and less ornate.[1]

The style of architecture of the preferred plan is that of

[1] Both of these plans are shown in perspective in Owen's "Hints on Public Architecture," the Gothic design facing page 99, the Norman, pages 104 and 108. The drawings of the accepted plan already possess some antiquarian interest, since they were lithographed from drawings by the architect, and show the structure as it was before the reconstruction of the east wing.

The battlemented cornices were not provided for in the first plans, but were an afterthought, it having been found by experience that too much of the roof was visible from the city.

the last half of the twelfth century; the latest variety of the rounded style, as it is found immediately anterior to the merging of that manner in the early Gothic. In the general design and most of the details the architect adhered to the period to which this style is referable. The general feeling, however, which permeates the design, especially in the upper towers, is that of a somewhat later era, when all lingering reminiscences of the post and lintel manner had been discarded and the ruling principles of arch architecture were recognized and carried out. The semicircular arch stilted is employed throughout, in doors, windows, and other openings. The windows are without elaborately traceried heads. The buttresses are not a prominent feature and have no surmounting pinnacles. The weather-moldings consist of corbel courses, with bold projection. The towers are of various shapes and sizes; and the main entrance from the north, sheltered by carriage porch, is between two of unequal height.

The design originally consisted of the main center building, two stories high, and two wings, of a single story, connected by intervening ranges, each of these latter having, on the north, or principal front, a cloister, with open stone screen.[1]

The extreme length of the building, from east to west, is 447 feet. Its greatest breadth, across the center of the main building and towers, and including the carriage porch, is 160 feet. The east wing is 82 by 52 feet; the west wing, including its projecting apse, is 84 by 40 feet, and 38 feet high; and each of the connecting ranges is 60 by 49 feet. The main building is 205 by 57 feet, and, to the top of its corbel course, 58 feet high.

[1] The east wing has since been entirely rebuilt, and the connecting range being now four stories high, the cloister at this end has disappeared, while in the west connecting range it has been inclosed to form a part of the building.

The main building has in the center of its north front two towers, of which the higher reaches an elevation of 145 feet. On its south front it has a single massive tower, 37 feet square, including buttresses, and 91 feet high. On its north-east corner stands a double campanile, 17 feet square, and measuring to the top of its finial 117 feet high. At its south-west corner is an octagonal tower finished with open-work in its upper portion; and at its southwest and northwest corners are two smaller towers. There are nine towers in all, including a small one at each wing.

In concluding his description of the plan given in "Hints on Public Architecture," Doctor Owen writes:

"I am not acquainted with any actual example yet remaining from what has been variously called the Lombard, the Norman, the Romanesque, and the Byzantine school, with which the Smithsonian building will not favorably compare. In so far as the architect has permitted himself to innovate upon ancient precedents from the style in which he designed, he has done so, in my judgment, with discretion and advantage. . . . I esteem myself fortunate in being able in this book to refer to an actual example, at our seat of government, the architect of which seems to me to have struck into the right road, to have made a step in advance, and to have given us in his design not a little of what may be fitting and appropriate in any manner (should the genius of our country hereafter work out such) that shall deserve to be named as a National Style of Architecture for America."

In compliance with the requirements of the organizing law, the building contained provision for objects of natural history and a geological and mineralogical cabinet, a chemical laboratory and library, and gallery of art, and lecture-rooms.

A building committee of three was appointed, consisting of Doctor Robert Dale Owen, who acted as chairman, Mayor

William W. Seaton, and General J. G. Totten.[1] This committee, having been empowered to enter into contracts for the completion of the building, began its sessions February 17, 1847, and within thirty days had decided upon the materials to be used, and awarded the contract for building.

It was at first intended that the plan should be executed in white marble. The quarries at Cockeysville, Maryland, whence was procured the stone used in building the Washington Monument, were carefully examined with this in view. Other quarries and materials were also considered, and about twenty-five different samples were tested with reference to their weathering qualities by Professor Charles G. Page. Doctor David Dale Owen, of Indiana, was invited to Washington to make surveys of the marble quarries in Baltimore County, and the sandstone quarries in Montgomery County, Maryland. Doctor Owen reported that the brown freestone obtained in the neighborhood of Seneca Creek, on the Potomac river, about twenty-one and a half miles from Washington, was of great beauty and durability, and he strongly recommended its use. This was found to be attended with so much economy that it was finally decided upon; the offer of the lowest bidder for construction having been $205,250 for the building in Seneca ashlar, while white marble ashlar would have cost $23,000 more.

The journal of the building committee for the year shows that between February 17 and November 26 it held forty-one meetings. Its transactions are reported with great minuteness in the appendix to the second report of the Board of Regents of the Smithsonian Institution,[2] and also in the vol-

[1] During General Totten's absence in Mexico in the early part of the year, his place upon the committee was taken by Mr. William J. Hough.

[2] Report of the Board of Regents of the Smithsonian Institution, January 6, 1848; Thirtieth Congress, First Session, Senate Miscellaneous Document, No. 23. The report of the building Committee is contained in this volume and forms pages 4–156. This report

ume entitled "Hints on Public Architecture," which was prepared by Doctor Owen, with the assistance of Mr. Renwick, and was one of the earliest publications of the Institution.

The actual location of the building was determined March 20, 1847, by a resolution of the committee that it should be placed "upon the center of the lot, or site, of the said Institution, from north to south, and upon the center of Tenth Street."

On May 1, 1847, the corner-stone of the building was laid with imposing ceremonies. The event was made the occasion of a public holiday. A procession was formed at City Hall, under the direction of William Beverly Randolph, Marshal-in-Chief. The procession, which was more than a mile in length, was composed of the militia of the District of Columbia, the various local Lodges of Free and Accepted Masons, together with delegations of Masons from Baltimore, the District of Columbia, and Alexandria, and marched to the music of three military bands. The column moved along F Street to the Executive Mansion, where the President and his cabinet, the heads of Departments and the Diplomatic Corps were received in line. It then proceeded by the way of Pennsylvania Avenue and Twelfth Street to the site of the building. A platform was erected on the south side of the site, and to this the high officials, the Regents of the Institution, the Mayor and Corporation of Washington, and other guests were escorted. The Masonic bodies then passed up to the corner-stone, which was laid by the Grand Master of the District of Columbia, Mr. Benjamin B. French, accompanied by Colonel James Page and Mr. Charles Gilman, Grand Masters of Pennsylvania and Maryland. Mr. French held in his hand the gavel used by President Washington in laying the corner-stone of the Capitol of the United States, and wore the Ma-

is not included in the first five reports of the Institution, issued in 1852, and but few copies are in existence. It is reprinted in "Journals of the Board of Regents, Reports of Committee," etc., by William J. Rhees, Washington, 1879, pages 597–695.

sonic apron presented to Washington by the Grand Lodge of France through General Lafayette, also worn by Washington on the earlier occasion. A prayer was offered up by Grand Chaplain McJilton, of the Grand Lodge of Maryland.

An address was delivered by Chancellor Dallas and a national salute was fired by the Columbia artillery, while the band played a national air. Benediction was then pronounced by the Reverend French S. Evans, "and thus," writes a witness, "were concluded the ceremonies of the day, which were witnessed by at least six or seven thousand persons."[1]

Although the time estimated as necessary for the completion of the building was five years, considerable progress had been made before the end of 1847. The work was carried on under the superintendence of James Renwick, Jr., the architect, and of Robert Mills, assistant architect.

In April, 1849, the east wing of the building was ready for occupation by the Secretary and his staff, and before the end of the year the west wing was also completed and was being temporarily fitted for occupation by the library.

During the year 1850 the work continued on the interior of the center building, but as the committee had adopted a resolution, "directing the interior of the center building to be constructed in fire-proof, and that the time be extended until the accumulating interest would be sufficient to meet the additional expense," the completion of the building proceeded very slowly. As far as the employment of fire-proof material was concerned, the committee wisely argued that the additional cost would be repaid by the permanence of the

[1] Second Annual Report, pages 132–143, where the address of the Chancellor is given. It was reprinted as "Address delivered on occasion of Laying the Cornerstone of the Smithsonian Institution, May 1, 1847," by George M. Dallas, Chancellor of the Institution. Washington: Printed at office of Blair & Rives. 1847, October. Pages 1–8.

building, and the perfect security that would be afforded to the valuable collection that would be preserved in that portion of the building. It was hoped that the towers would be finished and roofed in during the winter, but this unfortunately proved impossible.

The construction of the interior of the main building was continued during 1852, and the materials used were fireproof.

It was during this year that the contract between the Board of Regents and the builder was declared completed by the architect. This included the finishing of the exterior of the entire building, the interior of the exterior wings and connecting ranges, and the interior of the towers, leaving the whole interior of the main building to be finished. This covered a space 200 feet long by 50 feet wide and about 60 feet high, to be divided into a basement and two stories. The valuable services of Mr. Renwick were discontinued, and Captain Barton S. Alexander, of the United States Engineer Corps, was detailed to take charge of the construction. Captain Alexander promptly prepared plans for the completion of the work. The consideration of these and the procuring of estimates required some time, so that the new work did not begin until June 13, 1853.

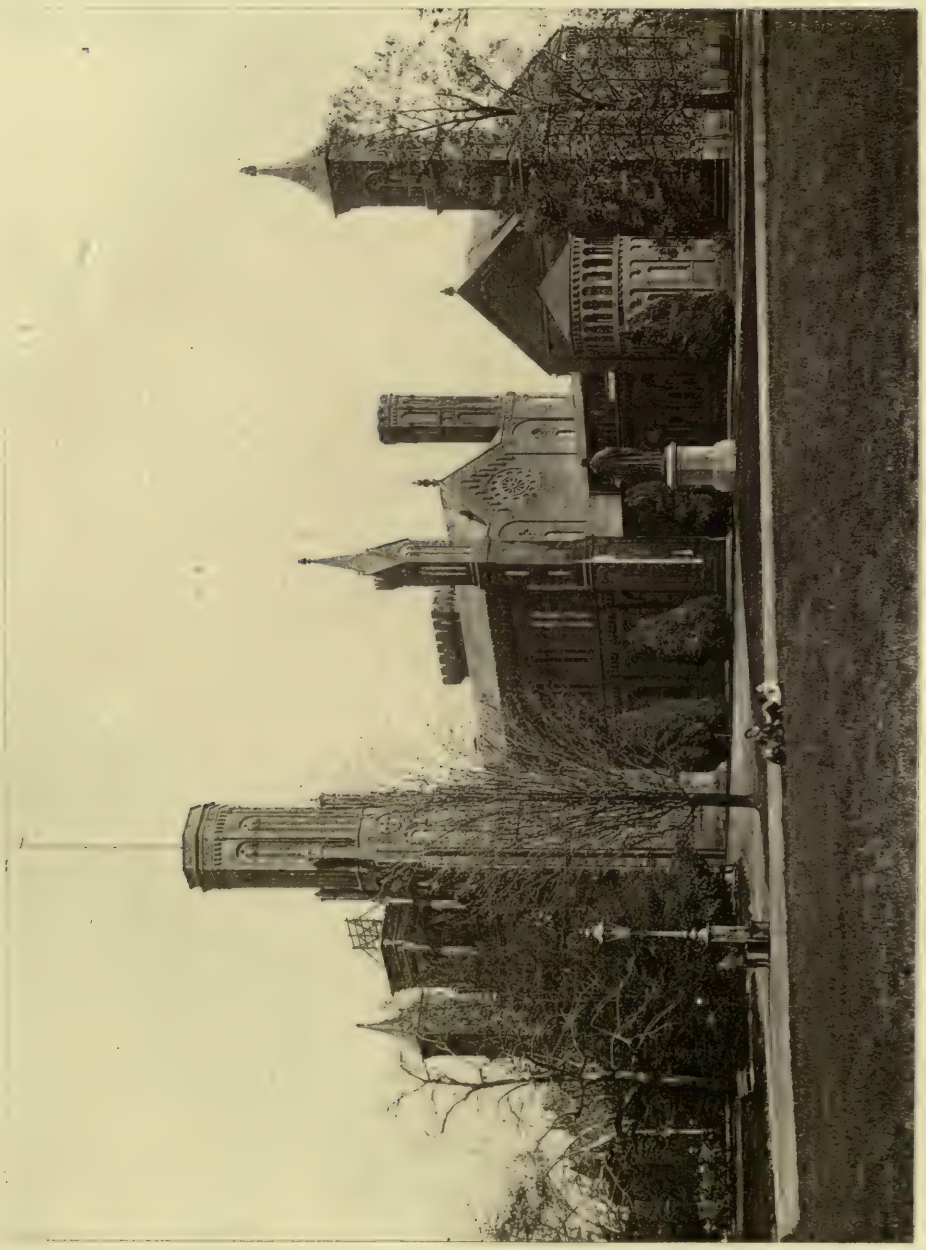
In the Report for 1853 the building committee reported that the roof had been temporarily secured, the wooden framework which had occupied the interior of the building removed, and that an excavation had been made for a cellar. It was further reported that the foundation walls, piers, and arches of a large basement had been completed; piers built in the main story, and, in fact, about nine-tenths of the brickwork finished as well, leaving as unfinished work the necessary stairways for lecture-room and gallery, the supporting of the roof in such a manner as to do away with the columns

in the second story, flooring, plastering, and painting to complete the interior finish, and providing seats for the lecture-room.

According to the Report of the committee for 1855, it would appear that early in the year the edifice was completed, and the final report of the architect approved by the committee.

As various changes were made in the original plan, the following brief description of interior arrangements will not be inappropriate. The interior of the east wing was separated into two stories, the upper of which was divided into a suite of rooms for the accommodation of the family of the Secretary; the lower story comprised principally a large single room, appropriated to the storage of publications and the reception and distribution of books connected with the system of exchange. The upper story of the eastern connecting range was divided into a number of small apartments devoted to the operations in natural history, and the lower story was fitted up as a working laboratory.

The interior of the main edifice, 200 feet long by 50 feet wide, consists of two stories and a basement. The upper story was divided into a lecture-room capable of holding two thousand persons; and into two additional rooms, one on either side, each 50 feet square, one of which was appropriated to a museum of apparatus, and the other at that time to a gallery of art. Both were occasionally used as minor lecture-rooms and for the meetings of scientific, educational, or industrial associations. The lower story of the main building consisted of one large hall for a museum or a library. It was unoccupied at first, but was used, as the means were provided for furnishing it, with proper cases for the exhibition of natural history and other collections. The basement of this portion of the building was used as a lumber-room and as a receptacle for fuel.



The west wing was occupied as a library and was sufficiently large to accommodate all the books that were received during the ten years following its completion.

The principal towers were divided into stories, and thus furnished a large number of rooms of different sizes, which came in time into use in the varied operations of the Institution. A large room in the main south tower was appropriated to the meetings of the Establishment and the Board of Regents; three rooms in one range, in the main front towers, were used as offices; and two rooms below, in the same towers, were used for drawing, engraving, and workshops. There were in the whole building, of all sizes, ninety different apartments, of which eight were of a large size, and were intended for public exhibitions.

In order that the principal of the Smithsonian fund should not be encroached upon for building purposes, it was necessary, as has been shown, to proceed slowly, and this proved of further advantage, for, to quote Secretary Henry:

"The delay in finishing the building has not only been attended with advantage in husbanding the funds, but also in allowing a more complete adaptation of the interior to the purposes of the Institution. It is surely better, in the construction of such an edifice, to imitate the example of the mollusk, who, in fashioning his shell, adapts it to the form and dimensions of his body, rather than that of another animal who forces himself into a house intended for a different occupant. The first point to be settled, in commencing a building, is the uses to which it is to be applied. This, however, could not be definitely ascertained at the beginning of the Institution, and hence the next wisest step to that of not commencing to build immediately was to defer the completion of the structure until the plan of operations and the wants of the Establishment were more precisely known."

In 1857 the building committee reported that the object for which they had been appointed might be considered accomplished, although a large portion of the interior of the edifice was still unfinished. Thereafter the building was carried on very slowly, and for some time only a very few workmen were employed on its construction.

The expenses for furnishing the interior, including the alcoves and galleries for books in the library, as well as the cases for the specimens in the museum, were defrayed by a special appropriation from Congress. The building committee was continued in charge of such matters, although no formal report was made between 1857 and 1866.

On January 4, 1865, a fire occurred in the Smithsonian building which destroyed the roof and all of the interior of the upper story of the main portion of the edifice, the interior of the two large north towers and also of the large south tower. Fortunately, the loss to the Institution was not very great, although the burning of the roof of the main building caused the destruction of the contents of the second-story rooms immediately beneath it, and also those of the three principal towers adjacent. Besides the official correspondence and other papers, and the duplicate copies of published documents, the personal effects of Smithson, including numerous manuscripts written by himself, were almost entirely destroyed. The apparatus presented by Doctor Robert Hare, the lens used by Priestley in the evolution of oxygen, and many other pieces of apparatus in the collection were seriously damaged, but not sufficiently to prevent their restoration. The most important loss was the destruction of a large collection of paintings belonging to Mr. J. M. Stanley, but as these were his personal property and not insured, the loss fell on him.

The first steps toward the reconstruction of the building was to secure the services of a competent person as architect

and engineer to prepare the plans and superintend the work. For this purpose Mr. Adolph Cluss was employed, under the direction of a building committee consisting of Richard Delafield, Richard Wallach, and Joseph Henry. He made a critical survey of the building to ascertain the actual state of the walls and to determine what parts it was necessary first to repair. This survey revealed the fact that the original construction was defective, and in many respects the building was unsuited as a repository for records and other valuable articles. In consequence it was determined to not only restore the ravages made by the fire, but also to rebuild the defective parts so as to render the building thoroughly fire-proof and entirely stable both as regards material and mode of construction. The expense of this reconstruction was estimated to be about $150,000, and the building operations were continued until 1867, during the summer of which year the building was again ready for occupancy.

Since that date changes have been made from time to time in accordance with the requirements of the Institution. Of these perhaps the most important have been the transfer of the executive offices to the east wing of the building, formerly occupied by Secretary Henry as his private residence, and the reconstruction of this wing and the connecting range in 1884, whereby more commodious quarters were secured.

In 1880–'81 the growth of the museum compelled the erection of an annex building, to contain the overflow of the collections; and an appropriation of $250,000 was made by Congress and a simple structure of brick, iron, and glass was built close to the Smithsonian building, upon the southeast. This building is entirely devoid of architectural pretensions, and does not require many words of description. It should be stated, however, that the object of the building committee having it in charge was to obtain the largest possible amount

of space with the very limited appropriation. The plan was designed by General Montgomery C. Meigs, U. S. A., well known as an engineer and as the superintendent of the extension of the United States Capitol, aided by Adolph Cluss, by whom the plans were drawn and the structure superintended. The building is 300 feet square and one story in height, with pavilions three stories high at each corner, and in the center of each side. In addition to the seventeen exhibition halls, there are in the pavilion 160 rooms for offices and workshops. The amount of floor space available for exhibition purposes is 90,000 feet, the cost for each square foot having been less than $2.50. Notwithstanding the extreme economy of the structure, which has cost less than 25 per cent. as much for the accommodation afforded as any other permanent building ever erected, it was completed for less than the amount of the appropriation, and a small balance recovered into the treasury. The floors are laid directly upon the earth, and the building is absolutely without basement rooms. There is thus no opportunity for work rooms and store rooms, which is a most serious defect. In other respects, however, as the experience of 15 years has demonstrated, the building is admirably suited for its purposes, and has been much more useful than many far more pretentious and costly structures.

In 1890 a small structure for an astrophysical observatory was erected on the grounds immediately south of the Smithsonian building and a description of it, together with the ground plan showing the location of the principal instruments, is given in the chapter on the Astrophysical Observatory.

The grounds were first laid out under the directions of the Regents in 1849, and planted with trees and shrubs, comprising about one hundred and fifty species, chiefly American, and were inclosed in a hedge of Pyrocanthus, Osage

Orange, and Cherokee Rose, and ornamental gateways gave access to the grounds from the adjoining streets.

The original planting was soon replaced, however, by a more elaborate system, designed by Andrew J. Downing, who was invited by President Fillmore to lay out the entire Mall, from the Capitol to the river. This plan is the one still in use, although the untimely death of its designer interfered with its proper execution, since many trees planted for temporary purposes were allowed to remain, and to injure or destroy more hardy species, intended to be permanent in the final effect. The conception was, however, one of the most successful of all ever carried out by Mr. Downing, and has done much to perpetuate his fame as the earliest and one of the greatest of American landscape gardeners. His memory is honored by a monument in the form of a marble vase[1] which stands in these grounds northeast of the Smithsonian building. It is about 200 feet east of the Smithsonian Institution and about 640 feet north.

A bronze statue of Professor Henry, by William W. Story, was ordered by provision of Congress enacted in 1880, and was erected in the Smithsonian grounds about one hundred and fifty feet to the northwest of the building. The statue was unveiled on April 19, 1883, at the time of the annual meeting of the National Academy of Sciences, on which occasion a brief address by Chief Justice Waite was delivered, in which he said, "The statue which will now be unveiled has

[1] The design for this memorial was made by Calvert Vaux, who for many years was Mr. Downing's associate in business. Its execution was by Robert Launitz, a well-known sculptor. On the front side of the monument is the following inscription:

"This vase
Was erected by his Friends
IN MEMORY OF
Andrew Jackson Downing,
Who died July 28, 1852, aged 37 years."

On the base of the pedestal are the following words:

"THIS MEMORIAL
Was erected under a resolution passed at
Philadelphia,
in Sept., 1852, by the
American Pomological Society,
of which Mr. Downing was one of the
Original founders."

been erected by the United States as a token of gratitude for the labors of his useful life, and for his faithful administration of the important public trust so long in his keeping."

Subsequent to the unveiling an oration was delivered by President Noah Porter, of Yale College.[1]

[1] A full report of the proceedings is given in the Smithsonian Report, 1883, page 17.

THE SMITHSONIAN LIBRARY

By Cyrus Adler

THE SMITHSONIAN INSTITUTION is a world institution; its funds are held in trust by the government of the United States for the benefit of all men; its influence, spread as it is throughout the world, cannot be readily seen, nor counted, nor measured. In spite of the evidences of its work in the promotion of science, through the publications, the Museum, the Bureau of Exchanges, the Bureau of Ethnology, the Astrophysical Observatory, and its other well-known agencies, no one acquainted with its inner working can doubt that all of these put together represent but a fractional part of its share in the intellectual activities of the world. Of no department is this statement so true as of the library.

The idea of the formation of the library may be said to be contemporaneous with the first announcement of the Smithson bequest, and to antedate the establishment of the Institution itself. In all the discussions in Congress relating to the utilization of the bequest, the idea of a library played a prominent part. In the Twenty-sixth Congress (1839–'41) a bill was introduced "to provide for the disposal and manage-

ment of the fund bequeathed by James Smithson to the United States." This bill would have appropriated the larger part of the sum for the establishment of an astronomical observatory, but even with this as the main purpose, it included the following items:

"For the library, one year, $30,000; $10,000 for the first supply; $20,000 for a fund for an income of $1,200 a year, for a constant supply of new works and periodical publications upon science in other parts of the world, or in America."

Senator Choate, of Massachusetts, strongly advocated the use of a large part of the fund for library purposes. In a speech delivered on January 8, 1845, he said:

"We cannot do a safer, surer, more unexceptionable thing with the income, or with a portion of the income — perhaps twenty thousand dollars a year for a few years — than to expend it in accumulating a grand and noble public library — one which, for variety, extent, and wealth, shall be, and be confessed to be, equal to any now in the world."

At the conclusion of his speech, Mr. Choate moved to amend the bill under consideration by the insertion of the following clause:

"And whereas, an ample and well-selected public library constitutes one of the permanent, constant, and effectual means of increasing and diffusing knowledge among men; therefore, be it further enacted that a sum not less than $20,000 be annually expended, of the interest of the fund aforesaid, in the purchase of books and manuscripts for the formation of a library of the institution aforesaid, which, for its extent, variety, and value, shall be worthy of the donor of the said fund, and of this nation, and of the age."

On January 9, 1845, the debate in the Senate was resumed.

The first section of the bill contained the following clause:

"Provided, That the books to be purchased for said institution shall consist of works on science and the arts, especially such as relate to the ordinary business of life, and to the various mechanical and other improvements and discoveries which may be made."

Mr. Choate moved to strike out this proviso "to avoid a premature decision on the point at issue as to the plan of a general library, or a special one limited to works on physical science."

Senator Tappan, of Ohio, opposed the motion. "He argued that a library limited to the works on sciences and the arts, specified in the proviso, would be the only suitable and appropriate library for the institution."

Senator Pearce, of Maryland, agreed with Mr. Choate and desired that the Institution should become a "complete national library."

Mr. Choate's resolution to strike out the provision finally prevailed.

Mr. Choate next moved to strike out the eighth section, and to substitute the amendment given above.

Senator Crittenden, of Kentucky, moved to add a proviso limiting the classes of books which might be purchased.

"Mr. Choate argued that this limitation was not only unnecessary, but would most certainly prove injurious. It was unnecessary, because no national library, such as he contemplated, and such as he hoped the Senate would authorize, could be made complete without every one of the works on science and the arts which the Senators for Ohio and Kentucky could possibly desire."

Senator Rives, of Virginia, thought "if we were to have a library at all to carry out this great object, it really seemed

to him that the library ought to be coextensive with the limits of human knowledge."

Senator Niles, of Connecticut, "did not think it came within the purpose of the donation to establish a great national library. If the donor thought that the best way of increasing and diffusing knowledge among men, he would have enjoined the establishment of such a library."

Mr. Tappan moved an amendment to add "$91,862 out of the interest due, to the original fund, so that the investment should be $600,000."

"Mr. Choate objected to this as, in effect, cutting off the means for establishing a national library."

The amendment was rejected.

The bill was recommitted to the Committee on Library, which on January 21, 1845, reported a new bill. It provided for a building "for the reception of an extensive library, equal to the first-class libraries in the world."

"An annual expenditure of not less than $20,000 out of the interest of the fund is authorized to be made in the purchase of books and manuscripts for the library of the institution, which library is to comprehend in due proportion, without preference or exclusion of any branch of knowledge, works pertaining to all the departments of human knowledge, as well as physical science, and the application of science to the arts of life, as all other sciences, philosophy, history, literature, and art; and for its extent, variety, and value, said library shall be worthy of the donor of the fund, and of this nation and the age. The managers to employ a librarian and assistants, and to fix their salaries; also to prescribe the regulations under which the library shall be kept, visited and used."

Senator Buchanan, of Pennsylvania, said he "had arrived at the conclusion that the best mode of distributing this fund was by the purchase of a great library."

It will thus be seen that Senator Choate, who believed most strongly in the establishment of a great library in the United States, was a determined advocate of employing the Smithson bequest in this manner. He actually succeeded in having adopted by the Senate of the United States, on January 23, 1845, the bill concerning the provision of which the foregoing is a discussion,—in effect, to devote the greater part of the income arising from the bequest to the establishment of a library. This bill failed of passage in the House, and was referred to in later debates as "the library plan."

The leading spirits in the Senate would have devoted the larger part of the fund to a library. The members of the House interested in the matter were opposed to this plan. Mr. Robert Dale Owen, of Indiana, in a debate on April 22, 1846, after reviewing the discussion in the Senate, introduced a bill which allowed an expenditure of $10,000 a year for books. He argued against the attempt to make a general library. He asserted that Smithson's tastes were scientific, and not antiquarian, and that had he desired to found a great library he would have said so. Mr. Ingersoll and some other members of the House agreed with Mr. Owen in his objection to the establishment of a great library, while Mr. Stanton, of Ohio, thought "that the annual appropriation of $10,000 for the gradual formation of a library might have been limited to a smaller amount." "The library plan," however, had friends as well as opponents in the House. Mr. George P. Marsh, of Vermont, on April 23, 1846, in speaking of the provision for the annual expenditure of $10,000 a year for the library, said: "I consider this the most valuable feature of the plan, though I think the amount unwisely restricted." And he proceeded to argue at great length in favor of a general library. He also moved several amendments, all with a view, as he said, to direct the appropriations entirely

to the purposes of a library. Mr. Owen argued, in reply, that a library might diffuse knowledge, but would not increase it. One of the ideas which was broached during these discussions was that the library should be peripatetic.

The Act which finally passed establishing the Smithsonian Institution was in effect a compromise between the views urged in the Senate and in the House; for whereas a library was mentioned as but one of the objects of the Institution, yet Section 8 of this Act expressly provides for a library in the following terms:

"The said Regents shall make, from the interest of the said fund, an appropriation, not exceeding an average of twenty-five thousand dollars annually, for the gradual formation of a library, composed of valuable works pertaining to all departments of human knowledge."

At the second meeting of the Board of Regents, held on September 8, 1846, a committee of three, appointed to digest a plan, reported a scheme which was adopted by the Board on January 25, 1847.

This report practically recommended that half of the income be set aside for a library and museum, and that the Smithsonian Institution become a center of bibliographical information for the entire country. The report fully expresses the aim of the Institution with regard to its own library, and the other libraries of the country. It begins with a statement that the proposition that the building about to be erected should contain library room sufficient to receive one hundred thousand volumes was made rather in the spirit of the charter and against the deliberate conviction of the committee, and then proceeds as follows:

"But, without a vast accumulation of books in this metropolis, your committee conceive that the Librarian of the

Smithsonian Institution may, under a proper system, become a centre of literary and bibliographical reference for our entire country. Your committee recommend that the librarian be instructed to procure catalogues, written or printed, of all important public libraries in the United States, and also, in proportion as they can be obtained, printed catalogues of the principal libraries in Europe, and the more important works on bibliography. With these beside him, he may be consulted by the scholar, the student, the author, the historian, from every section of the Union, and will be prepared to inform them whether any works they may desire to examine are to be found in the United States, and, if so, in what library; or, if in Europe only, in what country of Europe they must be sought. Informed by these catalogues, it will be easy, and your committee think desirable, for those who may be charged with the selection of books, to make the Smithsonian Library chiefly a supplemental one; to purchase, for the most part, valuable works, which are not to be found elsewhere in the Union; thus carrying out the principle to which your committee has already alluded as influencing all their recommendations, that it is expedient, as far as may be, to occupy untenanted ground.

"Exceptions to this rule must here, of course, be made; as in the case of standard works of reference required for the immediate purposes of the institution, and also of the very numerous works, many of current science, which, by a proper system of exchanges, we may procure without purchase. In this latter connection, the Transactions and Reports of the institution will obtain for us valuable returns."

In all the early discussions of the Board of Regents the library received the fullest consideration. Indeed, one of the first definite acts of that body was a resolution passed at its third meeting, September 9, 1846:

"That the Secretary be requested, without unnecessary delay, to collect, on behalf of the institution, all the documents,

Congressional and others, connected with the history of the Smithsonian bequest, and of its legislation, and cause them to be substantially bound, as a commencement of its library."

In a letter written by Professor Charles C. Jewett to Professor Henry, the former proposed that the library should consist of three classes of books; first, those which may be immediately needed in the scientific department; second, the bibliographical works and descriptions, histories, and catalogues of similar institutions; third, a general collection consisting of memoirs, transactions, and journals of the learned societies of Europe and America. "These three classes of books," he says, "will form a library quite unique, and one of great utility." There were other details of Professor Jewett's plan which will be referred to later.

These various ideas were reduced to form in the program of organization presented to the Board of Regents by Professor Henry on December 8, 1847, the following portions of which relate to the library.

"To carry out the plan before described, a library will be required, consisting, 1st, of a complete collection of the transactions and proceedings of all the learned societies in the world; 2d, of the more important current periodical publications, and other works necessary in preparing the periodical reports.

"With reference to the collection of books, other than those mentioned above, catalogues of all the different libraries in the United States should be procured, in order that the valuable books first purchased may be such as are not to be found in the United States.

"Also catalogues of memoirs, and of books in foreign libraries, and other materials, should be collected for rendering the institution a centre of bibliographical knowledge, whence the student may be directed to any work which he may require."

Professor Henry submitted this plan of organization in advance to a number of learned societies and individuals throughout the country for their criticism; and among the replies the following, from the American Academy of Arts and Sciences at Boston, is of unusual interest. This reply was signed by Edward Everett, Jared Sparks, Benjamin Pierce, Henry Wadsworth Longfellow, and Asa Gray. It stated:

"A library is one of the objects contemplated in the act of Congress establishing the Board for the management of the trust. It is requisite for carrying out the plan above proposed. At the same time it will be observed that the distribution by exchange of the publications, which that scheme of operations will call into existence, will rapidly provide the Institution, without farther expense, with the class of works, often of a costly character, which are most directly important as the means of advancing and diffusing positive knowledge. It is accordingly in these that the Secretary proposes to lay the foundations of the library; forming, 1st, a complete collection of the Transactions and Proceedings of all the learned societies in the world; and, 2d, a similar collection of all the current periodical publications, and other works necessary in preparing the contemplated periodical reports. . . . Such a library as the plan proposes may be fairly regarded as an important instrument for the increase and diffusion of knowledge."

It will thus be seen that, with very slight dissent, all the persons concerned in the early conduct of the Institution,—the members of Congress, the Regents, Professor Henry, and Professor Jewett,—concurred in the idea that the library should be, first, a library of science, and second, a collection of catalogues and bibliographical apparatus. While it may be said that portions of the original plan have, by force of circumstance, been somewhat modified, the most important has never been deviated from:

"To procure a complete collection of the memoirs and transactions of learned societies throughout the world, and an entire series of the most important scientific and literary periodicals."

This may be said, in brief, to have been the policy of the Institution, with regard to its library, from the beginning to the present day; although while making this its primary object the Institution has acquired many valuable works other than serials and journals, in almost every department of human knowledge.

The first librarian of the Smithsonian Institution was Charles C. Jewett, who was nominated Assistant Secretary acting as Librarian, by the Secretary, which nomination was approved at a meeting of the Board of Regents held on January 21, 1847.

While it is beyond the purpose of this chapter to discuss the personnel of the library of the Institution, Mr. Jewett is so unique a figure in the history of library work in America, and so much of his activity in behalf of the libraries of the country is contemporaneous with his stay in the Institution, that a brief reference to him is essential.[1]

Charles Coffin Jewett was born in Lebanon, Maine, on August 12, 1816. He studied in the Latin School in Salem, Massachusetts, and entered Dartmouth College in 1831, leaving it in his sophomore year for Brown University, and graduating in 1835. For two years (1835 to 1837) he was principal of the Academy in Uxbridge, Massachusetts. In

[1] The first biographical sketch of Professor Jewett was a brief address by Doctor Reuben Guild, printed in the Providence *Evening Press*, Friday, February 10, 1868, two days after Mr. Jewett's death. This notice was reprinted in Providence, in octavo form, and also in the "Smithsonian Report" for 1867, page 128. The most extended notice was also by Doctor Guild, being a memorial sketch of Professor Jewett, published in *The Library Journal*, Volume XII, November, 1887, pages 507–511. See also "Historical Catalogue of Brown University," Providence, R. I. (1764–1894), Providence, 1895, page 116; *New England Historical and Genealogical Register*, Volume XXII, 1868, page 365.

1838 he received the degree of Master of Arts from Brown University, and in 1840 was graduated at the Andover Theological Seminary. He had devoted himself more especially to philology, Oriental languages, and antiquities; and had made a plan for extended travels through the East.

"He was unexpectedly delayed in the accomplishment of this plan by the misdirection of a letter, and that apparently slight circumstance determined his subsequent course, and gave complexion to all his after life." [1]

While pursuing his theological course in Andover he assisted in the arrangement of the library and the preparation of its catalogue. From 1840 to 1841 he was the principal of Day's Academy in Wrentham, Massachusetts.

Brown University had been for some time making an effort to increase its library, and the Honorable Nicholas Brown had erected a special building for a library and chapel. It had been the custom for a member of the faculty, in addition to his teaching functions, to take charge of the library, but this plan was found unsatisfactory, and on October 7, 1841, the Board of Trustees passed a resolution that "Mr. Charles C. Jewett, of Salem, Massachusetts, be employed, under the direction of the library committee, to make out a new and approved catalogue of the University library."

This catalogue was completed and published in the autumn of 1843. It consists of two parts, a descriptive catalogue of the works in the library and an index of subjects, and at once brought Mr. Jewett into favorable notice, being declared "so original and intrinsically valuable, that it at once placed him at the head of the bibliographers of this country." [2] In 1843 Mr. Jewett was appointed professor of modern languages and

[1] *New England Historical and Genealogical Register*, Volume XXII, 1868, page 365.
[2] *Ibidem.*

literature in Brown University, a place which he held, as well as that of librarian, until 1848. His appointment was made with the understanding that he should have the opportunity of traveling for the purpose of familiarizing himself with the modern languages, and of making the acquaintance of librarians and library methods abroad. During this time he also purchased for the Brown University Library a collection of 7,000 books, which still forms one of the most choice portions of that valuable library.

As stated before, Professor Jewett was appointed assistant secretary and librarian by Professor Henry in 1847, but it was some little time before he actively began the work of collecting books. Meanwhile, he formed various projects which were of high importance for the development of American libraries. His ideas as to the proper functions of the Smithsonian Institution in library and bibliographical work entirely coincided with those of Professor Henry, and he early made an attempt to secure a complete catalogue of all the libraries in the United States. The method that he proposed was to secure two, or even three, copies of the printed catalogues of the various libraries, to supplement these by manuscript copies, and to make in this way a catalogue on slips, or cards, of all the libraries in the United States. It was this activity, and the correspondence which it occasioned, that brought about the publication of his "Notices of Public Libraries in the United States of America" by the Smithsonian Institution in 1851, which was "the pioneer attempt to give a description of all our libraries." [1]

[1] "Public Libraries in the United States of America." Special Report of the Bureau of Education. Washington, 1876, page xviii. A most useful elaboration of this work was published in 1859 by Mr. W. J. Rhees, under the title "Manual of Public Libraries, Institutions, and Societies in the United States, and British Provinces of North America." Philadelphia, J. B. Lippincott & Co., 1859. The various reports of the Bureau of Education as to the libraries in this country are its legitimate successors. See also *The Library Journal*, Volume XI, 1886, page 199.

Speaking of this publication Professor Henry said:

"The Report on the statistics of Libraries of the United States, prepared by Professor Jewett, has been ordered to be printed by Congress, as an appendix to the Regents' Report. A sufficient number of extra copies will be presented to the Institution, for distribution to all the libraries from which statistical information was received. It forms a volume of about two hundred and twenty-five pages, and will, I am sure, be considered an important contribution to Bibliographical Statistics."[1]

"This report is intended merely as a beginning, to be followed by others on the same subject. It has been sent to all the libraries of the United States, with the request that its deficiencies may be pointed out and additional materials furnished to render it more perfect. The great interest which is felt in this work is manifested by the amount of statistical information which has already been received and returned for the copies distributed."[2]

Professor Jewett had begun already in 1849, as a preliminary to his plan of making a general catalogue of books in the United States, to prepare a catalogue of all the books in the libraries of Washington; and much progress was made. Meanwhile, his plan for forming a general catalogue of the libraries of the United States was being carried on in conjunction with another plan, that of furnishing catalogues by a cheap and satisfactory process to individual libraries. Professor Jewett was of the opinion that the printing of catalogues of American libraries, most of which were repetitions of titles already printed, was a great waste of money and effort. He, therefore, proposed the plan of printing these catalogues by preparing a set of stereotyped titles, which

[1] "Smithsonian Report," 1850, page 14.
[2] Professor Henry in "Smithsonian Report," 1851, page 14.

were to be under the control of the Smithsonian Institution, but at the disposal of any librarian upon application. This plan he had already worked out in 1847, and had communicated it to Mr. Henry Stevens before the latter went abroad. He first proposed it in public at the fourth meeting of the American Association for the Advancement of Science, held in 1850; and later described it more at length in a pamphlet issued by the Institution, entitled "On the Construction of Catalogues of Libraries and a General Catalogue, and their Publication by Means of Separate Stereotyped Titles." A second and enlarged edition of this pamphlet, with quite a number of changes, was published in 1853.

It will be seen by a study of the rules drawn up by Professor Jewett, as well as by an examination of the specimens which accompanied the reports, that he is entitled to the credit of having paved the way for the valuable work in scientific bibliography to which so many of our countrymen have since contributed, and which is now assuming so great an importance to the learned men of the world. His description of a book is most accurate; a publication was to him as much an object of careful study as is a natural history specimen to a naturalist. His annotations were of great value and made with the most exact discrimination. He was, it is true, preparing catalogues and not bibliographies, and himself drew a careful distinction between these two classes of works. Yet he felt that the library catalogue should give some of the information which was in theory appropriate only to the bibliographical dictionary.

The scheme attracted at the time most favorable notice. In accordance with a rule of the Smithsonian Institution, it was referred to a commission, consisting of Edward Everett, Charles Folsom, librarian of the Boston Athenæum; Joseph G. Cogswell, superintendent of the Astor Library; George

Livermore, of Boston; Samuel F. Haven, librarian of the American Antiquarian Society, and Edward Everett Hale. This commission made a report favorable to the scheme, reserving, however, an opinion as to the merits of a new system of electrotyping which had been proposed as the more economical.

This plan of Professor Jewett has continued to meet with the commendation of librarians and bibliographers. Sabin[1] describes it as "a well written summary of all that has been done towards solving this difficult subject. Librarians and private collectors will find in it many valuable practical hints." Mr. Charles A. Cutter says:[2]

"Mr. Jewett's plan for a general catalogue of all the libraries in the country is well known. Something might have been done by the aid of the Smithsonian Institution, of which he was then librarian; but as the directors resolutely confined their efforts to the propagation of science, and as there was at that time no other national organization sufficiently strong to move in the matter, the plan came to nothing. It has been often mentioned since, in terms of regret and longing; but no one has had the courage or seen the way clear to make any definite proposal."

Doctor William F. Poole, at the Milwaukee conference of the American Library Association in 1886, spoke of Professor Jewett's "rules" as a simplification and improvement on the plan then employed at the British Museum. He said further:

"Another project he was much interested in at the time; and it was highly creditable to his enterprise and ingenuity. It is an honest attempt to lessen the cost of printing elaborate catalogues, which were then, and are now, absorbing funds which ought to be expended in books."

[1] "Bibliotheca Americana," Volume IX, 1877, page 268.
[2] *The Library Journal,* Volume I, 1877, page 220; see also Volume XIII, 1888, page 107.

Mr. George Watson Cole[1] says:

"We shall come back to Professor Jewett's ideas upon these points as being in all respects the most satisfactory. The recent revival of his method of printing by separate stereotyped titles, by the *Publishers' Weekly*, attests the soundness of his judgment."

The experiments with materials continued, the plan receiving the heartiest support and approval, both on the part of the Secretary of the Smithsonian Institution and the Board of Regents. Inasmuch as the Institution had not then a sufficiently large library on which an experiment could be made, it was decided that it would be advisable to attempt to publish a catalogue of the Library of Congress upon this plan, and the Secretary and the Regents called the attention of the Library Committee of Congress to the matter. Congress promptly appropriated $3,000 to begin the preparation of a catalogue of its library on the plan proposed by Professor Jewett. The work was immediately begun, and in 1853 Professor Jewett reported that upwards of 6,000 volumes had already been catalogued.

It has frequently been asked what became of this plan. No better description has ever been given of the causes of its failure than that of Doctor Poole before the American Library Association in 1886. He said:

"The material he [Jewett] used was a sort of clay from Indiana. Congress made an appropriation for executing the plan. I recollect that the librarians of the country generally favored it, and that I did not. I remember that I spoke of it at the time as 'Professor Jewett's *mud* catalogue.' My views concerning it were based on some practical knowledge of legitimate typography, and from specimens of the work which

[1] "The Future of Cataloguing," *The Library Journal*, Volume XV, 1890, page 174.

Professor Jewett exhibited.[1] . . . . It failed . . . . from mechanical defects in the process,— the shrinking and warping of the blocks in baking, and the intractable nature of the material when baked, which made the exact adjustment of the blocks on the press impossible. . . . It is not necessary, to be a successful man, that one should be successful in everything he undertakes. Errors, mistakes, and blunders even, mark the path of all the great inventors, and the benefactors of the race. One who was so full of resources and expedients in library economy as Professor Jewett could afford to make an erroneous judgment on the process of using baked clay in typography."

The first conference of librarians which ever assembled in the world was held in the city of New York, in 1853. Of this convention Professor Jewett was, says Doctor Guild, "to my certain knowledge the prime mover." He was the president of the convention, and upon its adjournment was appointed the chairman of its executive committee, and its reassembling was made subject to his call. The convention met on September 15, 1853, and was in session for three days. In speaking of this conference Doctor Poole said:

"Professor Jewett was the leading spirit in the call and management of the convention, and its President. Indeed, he may justly be ranked as the ablest and most zealous of the early American reformers in the methods of library management." "The convention of 1853 . . . . made a lasting impression on the minds of all the librarians who were present, and must be regarded as an era in American bibliography."

Sir Anthony Panizzi, the distinguished librarian of the British Museum, was invited to be present by Professor Jewett, and we learn from his "Life and Correspondence,"

[1] See also "Some Notes on Co-operative or Labor-Saving Methods of Printing Library Catalogues," by A. Growoll, *The Library Journal*, Volume XIII, 1888, page 280.

by Louis Fagan, that though he earnestly desired to accept this invitation, he was unable to attend. He writes to Mr. Haywood, July 21, 1853:

"As to my going anywhere, I have to tell you of a dream which I should like to become a reality. There is going to be a congress of librarians in the United States, which is to open on the fifteenth of September next, and where all the great questions connected with the management of a great library are to be discussed, and uniform principles adopted . . . . They wish me to go, and I should like it amazingly; but the expense is too heavy. I will try, if possible, to get enough from the trustees. Do you think it possible, in case of my going, that, if the packet is not full, I might have a cabin to myself?"

As bearing on Professor Jewett's own plans, this convention adopted the following resolutions:

"*Resolved*, That the thanks of this convention be presented to the Board of Regents and officers of the Smithsonian Institution for their steady and effective efforts for the increase and diffusion of knowledge among men; and particularly for the measures which they have adopted for the encouragement and promotion of the public libraries of our country."

"*Resolved*, That we have considered attentively the plan for constructing catalogues of libraries, and a general catalogue of the public libraries of the United States, by means of separate stereotype titles, originated and prepared by Professor C. C. Jewett, and developed by him while librarian of the Smithsonian Institution. That we regard it as an object of high importance to the interests of our public libraries, and to the promotion of learning, and worthy to share in the funds of the Institution and the zealous exertions of its officers; the more so as it is an enterprise which cannot be successfully prosecuted, except under the guidance, protection, and pecuniary support of this central establishment for the increase and diffusion of knowledge.

"*Resolved*, That we have learned with pleasure that Congress, on the recommendation of the library committee, made an appropriation for the practical testing of the plan in its application to the Library of Congress, and that the work is now in successful progress."

In 1855 a difference of opinion between Professor Henry and Professor Jewett caused the latter's retirement from the Institution. Both Doctor Guild and Doctor Poole expressed the opinion that Professor Jewett's retirement represented the culmination of a struggle between science and literature, in which science prevailed. It is hardly necessary to say that a struggle between science and literature would in no wise involve the question of a library. Science has much greater need of books than has literature; under the conditions which prevail among scientific investigators of the present day, and even of the earlier day, collections of books were absolutely essential for the prosecution of their studies. It was not so much a question of policy as it was a question of administration which occasioned the retirement of Professor Jewett.

His name will always be held in grateful remembrance at the Smithsonian Institution, as it is among all the librarians of America. The Institution has more than carried out the idea of the establishment of a great library in Washington, by the very substantial aid that it has given to the Library of Congress, and by its policy of coöperation with that library, on every occasion, to make it a truly national library. While it has abandoned the idea of publishing catalogues of libraries, it has probably rendered a greater service to libraries by the publication of a large number of scientific bibliographies.

Professor Jewett's retirement created a profound sensation in the Board of Regents and Congress. Senator Choate, who had been from the first an ardent supporter of the

library, pure and simple, tendered his resignation as a Congressional Regent thereupon. An investigation of the policy of the Institution followed; but the investigating committee, both in the Senate and in the House, supported the policy which Professor Henry had pursued.

Although offered the presidency of a college and a professorship in another college, Professor Jewett preferred to accept the office of Superintendent of the Boston Public Library, whose new building had just then been completed. The next ten years of his life were devoted to the development of this great library.

"It was a fortunate misfortune," said President D. C. Gilman, of the Johns Hopkins University, "that removed Professor Charles C. Jewett from the Smithsonian Institution and placed him at the head of the Boston Library."[1]

"He was chosen," says Doctor Guild, "because he was, by common consent, the ablest bibliographer and most accomplished librarian in the country. . . . For more than ten years Mr. Jewett has thus been identified with the best interests of learning in the metropolis of New England. The catalogues which he has prepared, and the rules for the government of the library which he has suggested, have served as models for similar libraries in all parts of the country."

He had the largest share in the preparation of the index to the catalogue of the Boston Public Library (1861), and published in the same year a plan for the circulation and use of the books in the upper hall of the Public Library. He proposed a system of charging books, which, with minor exceptions, is still in use there, and is the prevailing practice in most of the large libraries of this country.[2]

[1] "Development of the Public Library in America." An address delivered at the opening of the Cornell University Library, October 7, 1891, Ithaca, New York, by Daniel C. Gilman (formerly librarian of Yale College) published by the University, 1891, page 4.

[2] *The Library Journal*, Volume XIV, 1889, page 206.

Of the catalogue of Bowdoin College library, 1863, which was compiled mostly in accordance with Professor Jewett's rules, Mr. Sabin says that it was a model catalogue. "Our profession," says Doctor Poole, "is a debtor to Professor Jewett for his early and scholarly services in bibliography and in library economy"; and Mr. W. I. Fletcher, the accomplished librarian of Amherst College, mentions him as one of the five librarians who "should be held in everlasting remembrance."[1]

During the twenty years of the existence of the American Library Association hardly a conference has passed at which his name has not been mentioned with a full appreciation of his services.

Professor Jewett was then, by common consent, one of the most active librarians of his time; the originator of much of the system of methodical practice in library work which is now so generally adopted in the United States, and is beginning to be regarded with favor in the countries of Europe. Under his care the Smithsonian collection grew, in six years, to 32,000 volumes. He was one of the first imbued with the spirit of coöperation, out of which so much valuable library work has grown, and to which all the hope of future bibliographical work turns.

The decided indorsement by Congress of the policy pursued by Professor Henry marked, in a certain way, an epoch in the history of the Institution, releasing it from the obligation of creating a great library, as one of its main objects. Indeed, its more active coöperation with the library of Congress was foreshadowed at this time. One of the sources of the increase of the library was the copyright system. At one time, the Institution was actually charged with the granting of copyrights, and it published, in good bibliograph-

[1] "Public Libraries in America." Boston, 1894, page 80.

ical form, in the Report for 1850, a complete list of copyright articles (August 10, 1846, to December 31, 1849), the first of the kind, I believe, ever published, and one which has only been followed in recent years by the list issued by the Treasury Department. The care of the copyright articles, however, was more burdensome than advantageous to the Institution, and the Secretary and the Librarian repeatedly urged either the repeal or a modification of the law. The charge of the books and other articles, which came by virtue of the copyright act, and which added but little of any real value to the collection, was a serious drain on the funds of the Institution. In 1864 Congress had appropriated a considerable sum of money for the enlargement of its own library; and as the large collection of books, which almost entirely filled the west half of the Institution, had become, both for its preservation and care, too great a charge upon the resources of the Institution, and as the Secretary of the Institution was at this time alarmed by the fire which had recently taken place and had threatened the entire building, Congress, at the request of the Board of Regents, passed an act to provide for the transfer of the custody of the library of the Smithsonian Institution to the Library of Congress. Professor Henry said on this point, in 1865:

"The suggestion has been made in previous reports that considerable relief might be afforded to the Institution by the transfer of its library, under certain conditions, to the new and spacious halls which Congress is providing for its own library, and the importance of the proposition has been much enhanced by considerations connected with the recent disaster. The west wing of the building, in which the library is now contained, is not fire-proof, and is already filled to overflowing. To provide another depository for it, which shall render it entirely secure from fire, and be sufficient for its continued increase, will far exceed the means of the Institu-

tion, and, although some inconvenience would be experienced in regard to ready access to the books, yet, in consideration of the great value of the collection, by far the most perfect of its kind in the United States, it has been thought proper to ask Congress to allow the deposit of this library to be made in one of the new fire-proof rooms preparing for the extension of its own collection of books.

"I am informed by Mr. Spofford, the librarian of Congress, that these two new rooms will be sufficient to accommodate the Smithsonian library, and to furnish space for the growth of the Congressional library for the next fifteen or twenty years. The object of the transfer is, of course, not to separate this unique and highly-prized collection of books from its relations to the Smithsonian Institution, for it must still bear its name and be subject to its control, but merely to deposit it where its preservation will be more certain and its usefulness more extended."

This act made it incumbent upon the government to care for the collection, preserved to the Institution its customary use of its library, gave to it, through the Secretary, the use of the Library of Congress, and authorized the Institution to withdraw the library upon reimbursement to the Treasury for the expenses incurred in binding and care.

The passage of this bill through Congress aroused considerable interest. Senator Sumner, of Massachusetts, said, on March 22, 1866, "I am very much interested in that question. I have paid some little attention to the subject in advance." On March 27 the bill again came up. Senator Hendricks, of Indiana, inquired

"whether this bill contemplates the permanent transfer of these books to the Congressional Library? These books belong to the Smithsonian trust fund, which I think ought not to be diverted."

To which Senator Howe, of Maine, who was in charge of the bill, replied: "The Senator will see, if he looks over the bill, that it does not transfer the title of the books. It is the custody of the books that is transferred to the Congressional library for safe keeping, as well as for the better accommodation of the public." Senator Trumbull, of Illinois, enforced this statement:

"I will state to the Senator from Indiana that this is a mutual arrangement entered into between the Regents of the Smithsonian Institution and the Committee on the Library, satisfactory to both parties. It is thought to be safer to have them deposited there. There is danger of them at present, as the building in which they are is not fire-proof."

Professor Henry said, in speaking of the transfer of the books to the Library of Congress:

"To those who have not fully considered the subject, it might, at first sight, appear that this transfer of a large number of rare and valuable books from the building of the Institution would be attended with serious inconveniences, and be a virtual relinquishment of the control of property procured at the expense of the Smithsonian fund. But it will be evident, on a statement of the facts, that the advantages accruing to the Institution and the public from the transfer far outweigh any inconvenience which may arise on account of it; and that it will tend to increase the efficiency of the funds, while it adds to the security and even facilitates the general use of the library."

Mr. A. R. Spofford wrote in 1876 as follows:

"In the year 1866, the Library of Congress received a most important accession in the transfer to its shelves of the whole collection of books gathered by the Smithsonian Institution, and representing twenty years' accumulation since its estab-

lishment. This collection was a most valuable complement to the library already gathered at the Capitol. . . . With this large addition (numbering nearly 40,000 volumes) the Library of Congress became at once the most extensive and valuable repository of material for the wants of scholars which was to be found in the United States. By the terms of transfer of the Smithsonian library, Congress became its custodian during such time as the Regents of the Smithsonian Institution should continue the deposit, it being stipulated that the expense of binding and cataloguing of all books should be defrayed by Congress in return for this valuable and annually increasing addition to its stores. This arrangement, while it relieves the funds of the Smithsonian Institution from an annual charge in maintaining a library, secures to the National Library an invaluable scientific department without material cost; and the deposit, supplying as it does a much larger library of use and reference to the scholars of the country than is to be found in any one body elsewhere, is likely to be a permanent one."[1]

"The union of the library of the Institution with that of Congress still continues to be productive of important results. The Smithson fund is relieved by this arrangement from the maintenance of a separate library, while at the same time the Institution has not only the free use of its own books, but also those of the Library of Congress. On the other hand, the collection of books owned by Congress would not be worthy the name of a national library were it not for the Smithsonian deposit. The books which it receives from this source are eminently those which exhibit the progress of the world in civilization, and are emphatically those essential to the contemporaneous advance of our country in the higher science of the day."[2]

The books were actually transferred in 1866, and Doctor Theodore Gill, who had been for some time the librarian of

[1] "Public Libraries in the United States," Washington, 1876, page 256.

[2] "Smithsonian Report," 1873, page 27.

the Institution, was appointed an assistant librarian of the Library of Congress, and, as his especial duty, had under his care the publications of learned societies and scientific periodicals, which constitute the bulk of the Smithsonian library.

From this time on the Institution became, in a certain way, an office for receipt and record of publications. Exchanges were continued, but there was no other source of increase, while the entire care of the books was assumed by the Library of Congress.

With the great growth of the museum, consequent upon the accessions after the close of the Centennial Exhibition in Philadelphia in 1876, and the very much enlarged scientific activity which grew up in the Institution through the work of the body of scientific men placed in charge of these collections, it was found absolutely essential to have a working library of books at the Institution. The first considerable impetus to this collection was the gift by Professor Baird of his library, to form the nucleus of a library for the National Museum. This important gift he announced in the following words:

"In the increasing amount of routine work with which I am charged in the several capacities of Secretary of the Smithsonian Institution, Director of the National Museum, and Commissioner of Fish and Fisheries, it has become entirely out of the question to continue those special researches in zoölogy to which I devoted so much time in the early years of my connection with the Smithsonian Institution, and for which I had accumulated, at my own expense, a large number of important works. These I have now formally presented to the Library of the National Museum, feeling assured that they will do the most good in that connection."

To which he added the statement:

"The most important source of supply to the Library of the National Museum consists in the direct exchanges of publi-

cations for those of foreign museums, and of scientific societies, and of specialists in natural history. Little, if anything, however, comes in not obtained under similar circumstances by the exchanges of the Smithsonian Institution."[1]

In 1887 the present Secretary, Mr. S. P. Langley, when Assistant Secretary, in charge of the library and exchanges, inaugurated a new policy for the further increase of periodical and serial literature in the library of the Institution. He obtained, by correspondence with a large number of scientific men as well as through the aid of institutions of learning, an extensive list of learned societies and scientific periodicals, embracing thirty-six hundred titles, a fair proportion of which have since been added to the library by the exchange of publications. He drew up, at the same time, a code of regulations for the conduct of the library, which, with one or two additions, is still in force.

The library of the Smithsonian Institution, whose inception and development have been sketched above, consists of a methodical collection of the transactions of learned societies and scientific periodicals, and publications of academies and universities, throughout the world, made by steady effort, on a systematic plan, for a half century, and reinforced by liberal purchases in the early years to secure the back sets of important publications of this kind.

A collection of this sort was the ideal from the beginning. It was proposed in the first letter for the plan of the library sent by Professor Jewett to Professor Henry, before the former came to the Institution. In his fifth Report, Professor Henry, speaking of the collections of transactions and proceedings of learned societies, said:

"In a few years it is believed as complete a collection of these will be gathered as it is possible to obtain."

[1] "Smithsonian Report," 1882, page 34.

In 1854, in the ninth Report, he stated:

"The reading room of the library receives the leading periodicals of this country and Great Britain, together with a number from France, Germany, etc.; and, therefore, offers desirable facilities for the reading community of Washington, and for those who visit the seat of government, to keep up with the general progress of knowledge; while by means of the more profound transactions of learned societies the student is afforded the opportunity of becoming acquainted with the advances made in special branches of literature and science."

In the next Report it is emphasized

"that the Smithsonian library is intended to be a special one, as complete as possible in Transactions and all works of science."

In the Report for 1856 he stated:

"The series of transactions and scientific periodicals is gradually becoming more and more complete; and, in the course of a few years, this collection will be as extensive as any to be found in the Old World."

In 1858[1] Professor Henry said:

"The fact has been repeatedly mentioned in preceding reports that the principal object aimed at in the collection of the library is to procure as perfect and extensive a series as possible of the transactions and proceedings of all the learned societies which now exist or have existed in different parts of the world. It is to works of this character that the student of science is obliged to refer for the minute history of the progress of any special branch to which he may be devoted, and to ascertain accurately what has been published on his particular subject previous to commencing his own labors, or at least before he gives the results to the world, in order that

[1] "Smithsonian Report," page 36.

he may do justice to those who have preceded him in the same path, and have due regard to his own reputation in not publishing facts and principles as new discoveries which have long since been recorded in the annals of science."

In 1864[1] Professor Henry wrote:

"It was therefore deemed preferable and more consonant with the purposes of the Institution to form a special library, which might constitute, as it were, a supplement to the Library of Congress, and consist, for the most part, of complete sets of the proceedings and transactions of all the learned societies in the world, and of other serials essential for reference by students specially engaged in original scientific research. The efforts of the Institution to carry out this plan, which has since been sanctioned by Congress, have been eminently successful. Principally through exchanges, and occasionally by purchase, a more complete collection of the works above mentioned has been procured than is to be found in any library of the United States, or is easily met with even in Europe. The Institution has been assisted in making this collection by the liberality of many of the older libraries abroad, which, on application, have furnished from their duplicates volumes, and even whole sets, to complete series of works long since out of print, and which in some cases could not have been obtained through any other means."

Mr. Spofford[2] wrote in 1876 of this collection that it consists

"of the publications of more than two thousand societies and institutions without the limits of the United States, besides nearly all American societies which print their transactions or proceedings,"

which, he says, affords

"a rich repository of scientific results, continually increasing, for the reference and use of American scholars."

1 "Smithsonian Report," 1864, page 57.
2 "Public Libraries in the United States," Washington, 1876, page 684.

And, again,[1] he says that the collection is

"quite unique in the multitude of publications of learned societies in all parts of the world and in nearly all of the modern languages."

Between the years 1887 and 1894 new periodicals to the number of 1853 were added to the list, while 1042 defective series were either completed or filled out as far as the publishers were able to supply missing numbers.

In the year 1895 the Institution was currently receiving 3045 periodicals, magazines, and publications of learned societies. This number did not include all such publications arriving at the Institution, as many societies whose publications are issued irregularly had not been included in the periodical record. These publications were roughly divided into three classes, of which 1565 were devoted to pure science, 704 to applied science, and 776, called miscellaneous, included literary, artistic, and trade publications. All the well known modern languages were represented, and even some of the less known, among which might be mentioned Arabic, modern Greek, Finnish, and Japanese; and two publications in Volapük. Nearly one hundred publications have been added since this report was prepared.

Various catalogues have been printed, but none in recent years. The catalogue of these publications belonging to the library up to 1883 was at that time typewritten and bound together in thirteen large volumes, some of them consisting of more than one thousand pages; while since that time they are catalogued on a card record.

But although the library is devoted mainly to these publications, yet it is not wholly wanting in works of a different nature. Some of these have come through special gift.

[1] Page 256.

Thus, the library of the founder, James Smithson, which consists of 115 volumes and a collection of manuscripts, became the property of the Institution.[1]

The Duke of Northumberland presented, in 1859, a series of expensive illustrated works, privately printed, relating to the local history of the county which bears his name.[2]

The library which belonged to the National Institute and contained a large number of valuable books, especially relating to meteorology and ethnology, passed into the possession of the Smithsonian Institution.[3]

A large number of catalogues of libraries and of public institutions of the United States were collected; those of colleges were turned over to the Bureau of Education, forming the nucleus of its present collection.

In 1852 the Institution received from Mr. J. O. Halliwell, of England, 54 volumes, mostly folios, of original documents, consisting of bills, accounts, inventories, legal instruments, and other business papers, extending from 1632 to 1729, and intended to illustrate the history of prices in England.

The Prussian Government presented a copy of the great work on Egypt by Lepsius, and later that distinguished scholar himself presented a complete collection of his own works. The Ministry of Public Instruction at Paris sent the "Description de l'Égypte," published by order of Napoleon the First.

The Royal Library of Dresden presented a series of 232 original discourses or theses and tracts written by Luther or his contemporaries. The Reverend Doctor Morris, then librarian of the Peabody Institute at Baltimore, said of this collection that it was interesting to the bibliographer because all the copies were first impressions, and not reprints.

[1] See "Smithsonian Report," 1857, page 35.
[2] *Ibidem*, 1859, page 103. [3] *Ibidem*, 1862, page 16.

He added:[1]

"They present specimens of paper and printing which are very creditable to the artisans of that day, ranging as they do from 1518, the year after the Reformation began, to 1546, the year of Luther's death. These writings have come to us in the same type and paper in which they were distributed by thousands over the land at the dawn of the Reformation. While the language in which they are written, both German and Latin, is not as refined as that employed by scholars of the present day, and while the pictorial illustrations are coarse, yet these productions show the extraordinary progress which the typographic art had already made in the early part of the sixteenth century. Many of them have the title-pages ornamented with a broad margin of wood-cut figures, most of them mythological and grotesque, and all curious. They are specimens of the engraving of that day, exceedingly interesting to the student of the history of art, for these are undoubted originals, which collectors of ancient prints prize so highly. A few of them are unskilfully illuminated, probably executed by some incipient artist, who tried his hand on these coarse and cheap wood-cuts. The subjects of the pamphlets are diverse and curious, and the titles of many of those which are controversial, as was the general custom of that day, are expressed in language more forcible than refined."

The University of Tübingen presented twenty-eight folio and quarto volumes of rare and curious incunabula.

From the Honorable G. V. Fox, Assistant Secretary of the Navy, there were received 179 volumes, illustrating the physical geography, ethnology, and resources of the Russian Empire, which had been given to him by the Czar on the occasion of his visit to St. Petersburg to present a resolution of Congress congratulating that monarch on his escape from assassination.[2]

[1] "Smithsonian Report," 1866, page 30. [2] *Ibidem*, 1867, page 60.

From the Secretary of State for War of Great Britain there came, in 1868, a series of facsimiles of the national manuscripts of England, including documents belonging to each reign, from William the Conqueror to Queen Anne, arranged chronologically, so as to illustrate the changes in handwriting and the language of the different periods of English history.[1]

It sometimes happened that books were presented to the Institution by a special act of Congress, the report of the Wilkes Exploring Expedition and the works of Thomas Jefferson, John Quincy Adams, and Alexander Hamilton being notable instances.

From Mariette Bey came facsimiles of the Egyptian papyri in the Boulak, now the Gizeh, Museum in Cairo.

Another most interesting collection was received in 1874, being the gift of Major-General Lefroy, Governor of Bermuda, through his relative, Mrs. Dundas, of Canon Hall, Larbert, New Brunswick. Concerning these Mr. Spofford made the following report:[2]

"These original records form a collection of the highest interest and value as materials of personal and political history at a period which must ever remain the most important era in the annals of the United States. One of the volumes contains twelve reports submitted to the lords of Her Majesty's treasury by John Wilmot, Colonel Dundas, and the other commissioners, upon the losses and services of the claimants who were loyal to the British crown during the revolutionary war, and who were afterward indemnified by act of Parliament. Six reports in addition, signed by Colonel Dundas and Mr. J. Pemberton, commissioners, and extending from A. D. 1784 to 1789, are also embraced. Thirty-four of the manuscript volumes contain a large amount and variety of facts and testimony regarding the landed possessions and

[1] "Smithsonian Report," 1868, page 43.

[2] *Ibidem*, 1874, page 25.

personal property of hundreds of British subjects in the New England States, as well as in New York, New Jersey, Pennsylvania, etc. As most of these papers have never been published, they are the more valuable and original and unique repositories of information regarding the persons to whom they relate, the descendants of many of whom still survive among the people of the United States."

Alexander Dallas Bache, so intimately connected with the Institution in many capacities, presented his collection of rare scientific pamphlets.

The library of Henry R. Schoolcraft, containing many valuable ethnological works, has been permanently deposited with the Institution.

Robert Stanton Avery, who left the greater part of his estate to the Institution, also bequeathed his library of pamphlets and periodicals.

Another special feature of the library is the large collection of pamphlets and of books relating to scientific matters, and of the theses of universities; a great number of maps and works of a general literary nature, and books of reference. Among the sciences, meteorology was one which was especially represented by a rich collection of manuscript and published material. In accordance with its general plan of coöperation, the Institution delivered to the Weather Bureau all its manuscript material relating to meteorology.

In 1851 a very valuable collection of etchings, engravings, and books which had been made abroad with great care by George P. Marsh was purchased for the Institution. In reporting on this collection in 1850, Professor Jewett said: "This collection, though not the largest in the country, is believed to be the choicest." It contains the work of nearly every engraver of celebrity, among whom may be mentioned Dürer, Rembrandt, Da Vinci, Claude Lorraine, as well as special

folios of old Italian and German masters; also a collection of works relating to the history of art, very complete in its day. Another collection of engravings was presented to the Institution by Mr. C. B. King, in 1861.[1] From time to time there have been additions to this collection, largely by gift and occasionally by purchase.

The plan formulated by Secretary Langley, and executed under his direction, for the greater increase of the library of the Institution by exchange than had heretofore obtained, has been described above. This plan was so successful that the library has almost doubled in size within the past five years, the normal increase for a year now amounting to from thirty to thirty-five thousand entries of the record book. In fact, it may be fairly said that the library is now on a more favorable footing, so far as increase is concerned, than it was at the time when the Institution was first organized, and when almost half of its endowment was assigned for library purposes.

In addition to the library of the Institution proper Secretary Langley began, in 1891, the collection of

> "a limited number of books, not forming part of the Smithsonian deposit in the Library of Congress, obtained by purchase from the Smithsonian fund and retained at the Institution under the name of the 'Secretary's Library.' These books are mostly, but not exclusively, books of scientific reference, certain art serials being included among them."[2]

Various other small collections are now being made for the use of the Astrophysical Observatory, the Zoölogical Park, for the immediate use of the Institution, denominated "Office Library," and files of popular literary magazines for the employees.

[1] A catalogue of this collection is contained in the "Smithsonian Report," 1861, page 86.

[2] "Smithsonian Report," 1891, page 12.

To state the number of volumes which this collection represents is now almost impossible, since they have not been counted for a number of years; but it will give some approximate idea of the size of the library to say that, at present, that portion which is known as the "Smithsonian Deposit," in the Library of Congress, numbers 357,000 books, pamphlets, periodicals, and maps; and other collections, independent of the "Smithsonian Deposit," would considerably increase this number.

Yet this vast collection is not assembled in any one place so as to be visible to the eye and to make an impression by its mass. The greater portion of it is deposited in the Library of Congress, and it is expected that with the completion of the new building for that library a section of it, adequate for the purpose, will be assigned for the use of the Smithsonian Deposit, so that this great body of scientific literature will again become really available.

The Institution at present maintains a reading-room containing 500 bins for periodicals, and a reading-room for the complete sets of transactions of the six or seven great academies of the world. It is collecting such works of reference as are indispensable for the use of its staff, and maintains, in connection with the Museum, a working library, which had its origin in the gift of the library of Professor Baird. This collection now numbers some 25,000 works and about 10,000 pamphlets, which, while accessible to scientific men in Washington and elsewhere, are primarily intended for the use of the scientific staff of the Institution. The Museum library is itself divided into twenty-three sections, placed in the work-rooms of the specialists, containing most valuable books and series. These special collections range in number from 200 to 3000 titles. They are all received, accessioned, and catalogued in the central library. Each book or pam-

phlet delivered to a sectional library is receipted for, the receipt cards being so arranged as themselves to form a catalogue of the sectional library. The curator or officer in charge of each department is responsible for each book delivered to him, and his receipt therefor is held by the librarian. All general books of reference, all works relating to explorations, and all serials devoted to more than one subject are kept in the central library. The librarian may at any time recall any book from a sectional library, and a person coming to the central library to use a book which is in a sectional library can get it almost as readily as though it were actually on the shelves; so that the sectional libraries are, in fact, little else than alcoves distributed around the building, each one in charge of a specialist whose interest in his own department aids materially in the growth of the whole library, while the control of these sections is absolute, and no general interest suffers because of this specialization.

Realizing that in the near future it may be desirable that many important works belonging to the Institution (which it has been found more convenient, in view of the crowded condition of the Library of Congress, to care for at the Museum and the Institution) may be sent to the new library building, the Museum has made a steady effort to develop an independent library for the use of its scientific staff; but no clashing has ever taken place, and the entire work proceeds on a uniform plan, under entire coöperation.

It is thus manifest that the Smithsonian Institution, while not unmindful of the demands of general literature, and even art, has been steadily collecting the periodical literature of the world. It aims to gather from all quarters the memoirs of learned societies, the publications of museums, institutions, academies, and of scientific departments of government. Other libraries in America devote themselves to special sub-

jects; no one has found the means, or has had the desire, to make a great collection of this nature.[1] Professor Henry frequently said that coöperation, not monopoly, is the watchword of the Smithsonian Institution. Its policy has always been to devote itself to such useful fields of labor as no other institution could be found ready to take up.

The growth of its own library has been specially favored by the magnitude and value of the publications which it has had to offer in exchange, both those issued by Congress and those printed from its private fund. By means of its publications, and by means of its exchange service, the Smithsonian Institution has incidentally secured a library more valuable in actual amount and more unique in character than it could possibly have obtained had the plan of a library, pure and simple, so ardently advocated by Senator Choate, been carried out. Doctor G. Brown Goode, the Assistant Secretary of the Institution, estimated in 1895 that "the value of the books distributed since the Institution was opened has been nearly $1,000,000, or nearly twice the original bequest of Smithson."[2]

I have little doubt that the Institution has received in exchange more than the entire value of all the money expended for publications, and that its collection of scientific transactions and periodicals is one of the two most important, and possibly the most important, in the world.

[1] In accordance with the plan adopted for the federation of the libraries in Chicago, the John Crerar Library will devote itself in part to scientific and literary periodicals.

[2] "An Account of the Smithsonian Institution, Its Origin, History, Objects, and Achievements." City of Washington. For distribution at the Atlanta Exposition, 1895.

THE UNITED STATES NATIONAL MUSEUM[1]

BY FREDERICK WILLIAM TRUE

AMONG the powers conferred on Congress by the Constitution is authority "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."[2] A result of this provision was the establishment of the Patent Office and the assembling in connection therewith of numerous models of inventions.

A building for the Patent Office was erected in 1812, but it was destroyed by fire in 1836, and with it the models and records it contained.

"In the Patent Office building, and with it destroyed," writes Doctor Goode,[3] "there was gathered a collection of models which was sometimes by courtesy called the 'American Museum of Arts,' and which afforded a precedent for the

[1] Nothing could have been more desirable, or in every way more fitting, than that this chapter on the National Museum should have been from the pen of the late Doctor Goode, who alone possessed the ability to present the subject adequately. I have quoted from his printed papers as extensively as circumstances would permit, and the first part of the chapter is little more than a paraphrase of portions of his writings.— F. W. T.

[2] Article I, section 8.

[3] Goode, G. Brown. "The Origin of the National Scientific and Educational Institutions of the United States." "Annual Report of the American Historical Association for the year 1889," page 7.

larger collection of models and natural products, which remained under the custody of the Commissioner of Patents until 1858, when it was transferred to the Smithsonian Institution and became a part of the present National Museum."

Though an assemblage of objects of more or less scientific interest was thus early formed as an indirect result of the policy pursued by the government, the establishment of a national museum was earlier in the minds of many American statesmen, especially in connection with the educational institutes which it was thought the government should found for the intellectual advancement of the people.

In the plan for a federal university published in the *Pennsylvania Gazette* in 1788, and commonly credited to Madison,[1] section 8 relates to natural history, and in connection therewith the remark is made:

> "To render instruction in these branches of science easy, it will be necessary to establish a museum, and also a garden, in which not only all the shrubs, etc., but all the forest trees of the United States should be cultivated."

The plan for a "National Institution" put forth by Joel Barlow in 1806 includes mention of the natural history and art museums of France in the preamble, and in the plan itself (though ambiguously worded) are provisions for collections of minerals and philosophical instruments.

While these and other similar plans show that the formation of national collections of art and science was thought desirable by the fathers, they did not result directly in the establishment of museums under the government. The first really scientific collection that came into the possession of the government was probably, as Doctor Goode has remarked,[2]

[1] See Goode, *ibidem*, pages 66, 126, who believed Benjamin Rush, of Pennsylvania, to have been the author of the plan.

[2] Goode. "Genesis of the National Museum." Report United States National Museum, 1891, page 273.

Smithson's cabinet of minerals, which was delivered, with the remainder of the Smithson estate, into the hands of Richard Rush, the agent of the United States, in 1838. The collection is described by a committee of the National Institute as follows:

"Among the effects of the late Mr. Smithson is a cabinet which, so far as it has been examined, proves to consist of a choice and beautiful collection of minerals, comprising probably eight or ten thousand specimens. The specimens, though generally small, are extremely perfect, and constitute a very complete geological and mineralogical series, embracing the finest varieties of crystallization, rendered more valuable by accompanying figures and descriptions by Mr. Smithson, and in his own writing. The cabinet also contains a valuable suite of meteoric stones, which appear to be suites of most of the important meteorites which have fallen in Europe during several centuries."

Three years later, in 1841, there was formed in Washington, chiefly through the exertions of Honorable Joel R. Poinsett, of South Carolina, a scientific organization under the name of the National Institute, with the avowed purpose of assembling scientific collections. Article 14 of the bill of incorporation reads thus:

"The resident and corresponding members shall exert themselves to procure specimens of natural history, and so forth; and the said specimens shall be placed in the cabinet, under the superintendence of a board of curators, to be appointed by the directors. All such specimens, and so forth, unless deposited specially, shall remain in the cabinet; and, in case of the dissolution of the institution, shall become the property of the United States."[1]

The Institute was dissolved in 1861 and its collections deposited in the Smithsonian Institution. "By this so-

[1] Rhees, W. J. "The Smithsonian Institution: Documents Relative to its Origin," page 240.

ciety," remarks Doctor Goode, "the nucleus for a National Museum was gathered in the Patent Office building in Washington, and public opinion was educated to consider the establishment of such an institution worthy of the attention of the government of the United States."[1]

The first collections of any magnitude which the National Institute took under its care were those of the United States Exploring Expedition which was sent out by the Navy Department, under Lieutenant Wilkes, in 1838. Earlier expeditions under the auspices of the government had been organized, but they either made no collections or deposited such as they did make in private museums outside of Washington.

The first collections of the exploring expedition were received in Philadelphia in 1840 and were temporarily stored in a room belonging to the Philadelphia Museum. Poinsett induced the Secretary of the Navy, James K. Paulding, to forward these collections to Washington, and interested himself to secure from Congress an appropriation of $5000 to defray the cost of their transportation and subsequent arrangement.

In April, 1841, the collections were deposited in a portion of a room in the new Patent Office, designated for the purpose by the Secretary of State. Doctor Henry King, a geologist and mining expert and curator of the National Institute, was in direct charge. The compensation of the curator was paid from the appropriation of Congress already referred to.

With what rapidity collections accumulated under the charge of the National Institute may be learned from the

[1] Report of the United States National Museum, 1893, page 3. For a full account of the National Institute and its relation to the Smithsonian Institution, by Doctor Goode, the reader is directed to pages 38–48 of the present work.

report of the committee of the Institute dated January 1, 1842. This report recites that "the entire collection is deposited in the upper rooms of the Patent Office; it consists of:[1]

"Donations from foreign governments.

"Donations from other institutions, foreign and domestic.

"Donations from ministers and consuls abroad, and from officers of our Army and Navy.

"Donations from individuals and from members of the Institution. The Iowa collection of mineralogical and geological specimens, made by R. D. Owen, Esquire, under the direction of the Treasury Department.

"The collection of mineralogical and geological specimens which had been on deposit in the bureau of the Corps of Topographical Engineers.

"The collection of portraits of distinguished Indians, and the collection of Indian curiosities which had been on deposit in the War Department.

"The minerals, books, papers, and personal effects of the Smithsonian bequest.

"The two shipments which have been received from the exploring squadron, consisting of minerals, specimens of natural history, works of art, implements of war, and curiosities.

"The books, minerals, and works of art belonging to the late Columbian Institute.

"The books, papers, and proceedings of the late American Historical Society.

"Cabinets and specimens, deposited by members in trust, for public use."

These collections, according to the same report, comprised about 1000 books and pamphlets, 50 maps and charts, 500 castings in plaster (medals and seals), 186 paintings, about 1600 bird-skins, 160 skins of quadrupeds, 50 skins of fishes; 200 jars, 2 barrels, and 10 kegs of fishes, reptiles, etc., in

[1] Goode. "Genesis of the United States National Museum," page 347.

spirits; 50,000 botanical specimens, 3000 insects, several hundred thousand shells, 500 corallines, more than 2000 crustaceans, 300 starfishes, etc., 100 sponges, 7000 separate specimens of minerals, and 50 boxes of the minerals and geological specimens. Those engaged in caring for the collections at this time were the curator of the Institute, Doctor King, a taxidermist, a botanical assistant and two other assistants, a mechanic, and a laborer.

Thus was established what in reality was a National Museum, containing collections belonging to the government, sustained by an appropriation from Congress, and employing a curator and assistants. For a time prosperity seemed assured, but complications soon arose which proved disastrous in the highest degree not only to the museum but to the National Institute itself.

The room in the Patent Office set apart for the collections by direction of the Secretary of State was needed for the display of models of inventions, and the Commissioner of Patents made strong protests against its occupancy by the Institute.

In August, 1842, Congress authorized the occupancy, "until other provisions be made by law," and also appropriated $20,000 for the care and arrangement of the collections, but in addition ordered that the persons having the work in charge should be appointed by the Joint Committee of the Library.

Only a month earlier a charter had been granted to the Institute, in which all trusts previously held were confirmed. "The supporters of the Institute," writes Doctor Goode,[1] "were disposed to urge that this was applicable to the collections of the 'exploring squadron' at that time in the custody of the Institute. The question did not come up in a

[1] Goode. "Genesis of the United States National Museum," page 311.

troublesome way at this time, for the Library Committee, at that time [not] unfriendly, simply confirmed the choice of curator made by the National Institute, and appointed Doctor Pickering to the position, Doctor Pickering being thenceforth subject to the Congressional Committee, and only by courtesy acting for the National Institute."

A little later, in 1843, the Library Committee having no longer any consideration for the Institute, without consulting its officers, appointed the Commissioner of Patents to have general charge of the government collections, and Captain Wilkes, the head of the exploring expedition, to arrange and display them. Captain Wilkes proceeded with the work, pushing aside the collections of the Institute to make place for those of the government, yet professing an interest in the welfare of the Institute and the security of its property. The drift of matters came to the attention of the officers of the Institute only by rumor, but Colonel J. J. Abert initiated a correspondence with Captain Wilkes, inquiring whether he or his assistants would devote any time to the care of the collections of the Institute, and stating that if such was not the case the attention of the Institute would be immediately called to the necessity of otherwise protecting its property. The replies were not satisfactory. Captain Wilkes held that as he and his assistants were paid by the government they could not spend any time in working upon collections belonging to a private organization. Nevertheless, he expressed an intention not to disturb the collections of the Institute more than should be really necessary in working out those of the government, and to watch over them as far as possible.

A few months later, in a correspondence relative to the "Ontonagon" copper boulder now in the National Museum, the Commissioner of Patents took the same ground, and held

also that he had entire control over the room in which the property of the Institute was deposited.

At the end of 1843, therefore, the National Institute found itself bereft of the control of the government collections, without funds, except the membership dues, which were much in arrears, and without quarters for its large and rapidly accumulating collections.

"The real cause of the decline of the National Institute," writes Doctor Goode,[1] "was simple enough. Failing to secure grants of money from Congress, the society was overwhelmed by the deluge of museum materials, which in response to its enthusiastic and widely-circulated appeals came to it from all quarters of the world. The annual receipts from the assessment of members were insufficient to pay for the care of the collections, and although by virtue of the long term of its charter the collections were kept together until 1861, there was little science and little energy manifested in this administration."

While the events we have mentioned were taking place extended discussions were going on in Congress, and in the country generally, regarding the proper disposition to be made of the bequest of James Smithson. It is unnecessary in the present connection to consider the various views put forth further than to remark that several schemes included provisions for museums of natural history and the arts.

The act of incorporation of the Smithsonian Institution passed August 10, 1846, provided that the Regents, having selected a proper site, "shall cause to be erected a suitable building of plain and durable materials and structure, without unnecessary ornament, and of sufficient size, and with suitable rooms or halls for the reception and arrangement, upon a liberal scale, of objects of natural history, including a geologi-

[1] Goode. "Genesis of the United States National Museum," page 328.

cal and mineralogical cabinet; also, a chemical laboratory, a library, a gallery of art, and the necessary lecture rooms."

It is further provided that the Regents "may so locate said building, if they shall deem it proper, as in appearance to form a wing to the Patent Office building, and may so connect the same with the present hall of said Patent Office building, containing the National Cabinet of Curiosities,[1] as to constitute the said hall, in whole or in part, the deposit for the cabinet of the said Institution, if they deem it expedient to do so." This plan was not adopted.

Section 6 of the same act provides that "in proportion as suitable arrangements can be made for their reception, all objects of art and of foreign and curious research, and all objects of natural history, plants, and geological and mineralogical specimens belonging, or hereafter to belong, to the United States, which may be in the city of Washington, in whosesoever custody the same may be, shall be delivered to such persons as may be authorized by the Board of Regents to receive them, and shall be arranged in such order and so classed as best to facilitate the examination and study of them, in the building so as aforesaid to be erected for the Institution."

Considering the section relating to buildings mandatory, and under the belief that the collections belonging to the government must be accepted and housed, the Board of Regents of the newly-established Institution proceeded at once with the erection of a large brown-stone structure.

For various reasons the building was many years in construction, and during this period the first Secretary, Joseph Henry, became more and more pronounced in his opinion that the government collections should not be cared for at the expense of the Smithsonian fund. Indeed, he was in doubt

[1] See Goode, *op. cit.*, page 301.

whether the Institution ought to form extensive miscellaneous collections to be maintained permanently at the expense of its funds, although he fully appreciated the value of collections, and, as will presently appear, labored to carry out the program adopted for the Institution by acquiring and caring for such special collections as could be made the direct means of increasing and diffusing knowledge. In the Report for 1850 he remarked:

"It would not be in accordance with the spirit of the organization to expend the income in the reproduction of collections of objects which are to be found in every museum of the country. Natural history can be much more effectively promoted by special collections of new objects, by appropriations for original explorations and researches, and, above all, by assistance in the preparation of the necessary drawings, and by presenting to the world, in a proper form, the labors of naturalists. In conformity with these views, it has been resolved to confine the collections, principally, to objects of a special character, or to such as may lead to the discovery of new truths, or which may serve to verify or disprove existing or proposed scientific generalizations."[1]

Again, in the Report for 1851, perhaps thinking that his position regarding museums might be misunderstood, he wrote:

"I would distinctly disavow the intention of underrating the importance of collections in themselves. On the contrary, it ought to be the duty of the Smithsonian Institution to point out the means by which they may be made, and to aid in the work, to the extent of its ability, by embracing all opportunities which may offer for procuring specimens for distribution, and by facilitating exchange and assisting explorations."[2]

[1] "Smithsonian Report," 1850, page 21 (reprinted in Report for 1853, page 202).
[2] "Smithsonian Report," 1851, page 24 (reprinted in Report for 1853, page 227).

In the same connection he expressed his views regarding the importance of a National Museum, in the following words:

"Though the formation of a general collection is neither within the means nor the province of the Institution, it is an object which ought to engage the attention of Congress. A general museum appears to be a necessary establishment at the seat of government of every civilized nation. . . . An establishment of this kind can only be supported by government; and the proposition ought never to be encouraged of putting this duty on the limited, though liberal bequest of a foreigner. The Smithsonian Institution will readily take the supervision of an establishment of this kind, and give plans for its organization and arrangement, provided it be requested to do so, and the means for effecting the object be liberally supplied." [1]

In 1850 Professor Spencer F. Baird was appointed Assistant Secretary of the Institution in charge of publications and museum. He brought with him from Carlisle, Pennsylvania, not only a considerable zoölogical collection assembled by his own activity, but, what was vastly more important, a system of recording, assorting, and distributing collections which was sufficiently comprehensive and elastic to meet the needs of a great museum. In December, 1850, he placed in the hands of Secretary Henry a full outline of operations which he afterward carried into practice with the most signal success. He perceived that the numerous surveying parties which the government was sending out from year to year into the Western territories would be powerful agencies in increasing the knowledge of the natural history of the country if they could be induced to make collections of natural objects along the various routes they traversed. To this end the

[1] "Smithsonian Report," 1851, page 25 (reprinted in Report for 1854, page 227).

influence of the Institution was brought to bear on those officials of the government who had the several surveys in charge.

The extent and form of participation by the Institution in the explorations of the government surveys varied in different cases. In some instances the Secretary of War was induced to grant an officer of the Army leave of absence for the purpose of making scientific explorations in some little known part of the country. Again, the Institution furnished outfits and directions for collecting to such surgeons and other officers of the surveying and exploring parties as manifested an interest in natural history explorations. In some cases the personnel of an exploring party included a naturalist of known abilities and experience, and the Institution furnished every facility for collecting.

On this point Professor Baird, referring to the Mexican Boundary and Pacific Railroad surveys, reported in 1853 as follows:

"Without a single exception, all these parties have been fitted out at the Smithsonian Institution with all necessary instruments and apparatus for natural history research, much of it contrived with special reference to the exigencies of the particular service involved. Full instructions were also supplied, by which persons without previous practice were enabled to master all the general principles required for making observations and collections of every kind."[1]

The participation of the Institution also took the form of aid in the publication of results. Every year one or more publications based on the collections of the government parties were issued.

Fostered by the Institution, to whose interest Professor

[1] "Smithsonian Report," 1853, page 52.

Baird lent enthusiasm and untiring energy, the work of collecting yielded abundant fruits. In 1853, three years after his arrival at the Institution, Professor Baird, having worked along the lines laid down by Henry, in procuring such series of specimens as were calculated to open up new fields of study and to increase knowledge, was able to report on the wonderful development of the natural history collections in the following words:

"It may be well to call attention to the fact that it has been the work of but three years to raise this collection from nothing to the front rank among American cabinets, exceeding all perhaps in the number of new species first brought to light within its limits. Nor has effort been confined merely to the acquisition of specimens, but to their concentration in mass, so as to supply all working naturalists with the materials of research. As already stated, applications for such assistance are constantly being received, and always met with all possible promptness; so that scarcely any natural history monograph or memoir of any extent has been published in this country within a year or two which has not been indebted in this way to the Institution. From the care, too, taken to keep separate all the localities, however near together, of any species, the collection affords information in reference to the geographical distribution of species of the very highest value." [1]

At the end of a decade, in 1860, Professor Henry was able to say:

"The scientific material thus collected is very valuable, and, in number and variety of specimens and duplicates to illustrate the natural productions of the North American Continent, far excels any other collection ever made." [2]

1 "Smithsonian Report," 1853, page 54.
2 "Smithsonian Report," 1860, page 44.

While the Institution was thus exerting itself to obtain special collections to serve as the basis of research, the Commissioner of Patents was growing each year more desirous of having the use of the space occupied in the Patent Office by the national collections, and appealed frequently to Congress and to the Regents of the Institution to relieve him of their care.

In 1857, when Professor Henry brought the matter before them anew, they finally agreed that the transfer of the collections to the Smithsonian building should take place, but stipulated that an appropriation should be made to cover the expense of the transfer and the construction of cases in the Smithsonian building, and that the Secretary of the Interior should undertake to obtain from Congress, as before, an annual appropriation for the care of the collections. In his report for 1856 Secretary Henry said:

"For the present, it may be well to adopt the plan suggested in a late report of the Commissioner of Patents, namely, to remove the museum of the Exploring Expedition, which now fills a large and valuable room in the Patent Office, wanted for the exhibition of models, to the spacious hall of the Institution, at present unoccupied, and to continue, under the direction of the Regents, the appropriation now annually made for the preservation and display of the collections.

"Although the Regents, a few years ago, declined to accept this museum as a gift, yet, since experience has shown that the building will ultimately be filled with objects of natural history belonging to the general government, which, for the good of science, it will be necessary to preserve, it may be a question whether, in consideration of this fact, it would not be well to offer the use of the large room immediately for a national museum, of which the Smithsonian Institution would be the mere curator, and the expense of maintaining which should be paid by the general government."[1]

[1] "Smithsonian Report," 1856, page 22.

"I can find no record in the minutes of the Regents," writes Doctor Goode, "but have been informed by Mr. W. J. Rhees, of the Smithsonian Institution, that an urgent request for the use of the hall was made by the Commissioner of Patents and the Secretary of the Interior, and that the Board decided to grant this request on the condition that Congress should appropriate money for the construction of the cases and the transfer of the collections, and that the Secretary of the Interior should provide for the expenses of the care of the collections after their transfer in the same manner as before."[1]

The collections were transferred to the Institution in 1858. Professor Baird reported that year[2] that twelve separate collections were received from the Patent Office, of which the most considerable was the collection of the exploring expedition under Captain Wilkes. He estimated that the Patent Office collections together constituted about one-fifth of the objects in the Smithsonian museum. He pointed out also that there were then in the museum twenty-three other government collections which had never been in the Patent Office. These were chiefly assembled by the different field parties of the Pacific Railroad Survey, the Mexican Boundary Survey, and other government expeditions engaged in exploring the national domain.

The policy relating to the treatment of the collections adopted by the Institution was fully explained in the report of the Secretary for 1861, though in most of its essential features it was in operation as early as 1857. Secretary Henry remarks:[3]

"The specimens may be divided into two classes—first, those which have been described in the reports of govern-

[1] Goode. "Genesis of the United States National Museum," page 342.

[2] "Smithsonian Report," 1858, page 52. [3] "Smithsonian Report," 1861, page 41.

ment expeditions or the transactions of the Smithsonian and other institutions; and second, those which have not been described, and which consequently are considered of much value by the naturalists who are interested in extending the several branches of natural history. Of both classes the Institution possesses a large number of duplicates, in the disposition of which some general principles should be kept constantly in view. After due consultation with naturalists, the following rules, which were presented in the last report, have been adopted relative to the *described* specimens:

"First. To advance original science, the duplicate type specimens are to be distributed as widely as possible to scientific institutions in this country and abroad, in order that they may be used in identifying the species and genera which have been described.

"Second. To promote education, as full sets as possible of general duplicates, properly labeled, are to be presented to colleges and other institutions of learning that profess to teach the principal branches of natural history.

"Third. It must be distinctly understood that due credit is to be given to the Institution in the labeling of the specimens, and in all accounts which may be published of them, since such credit is not only due to the name of Smithson, but also to the directors of the Establishment, as vouchers to the world that they are faithfully carrying out the intention of the bequest.

"Fourth. It may be proper, in the distribution to institutions abroad, as a general rule, to require, in case type specimens to illustrate species which have been described by foreign authors may be wanted for comparison or other uses in this country, that they be furnished at any time they may be required.

"Fifth. In return for specimens which may be presented to colleges and other educational establishments, collections from localities in their vicinity which may be desirable shall be furnished when required.

"In the disposition of the *undescribed* specimens of the collection, it is impossible to be governed by rules quite as

definite as those which relate to the previous class, but the following considerations have been adopted as governing principles:

"1. The original specimens ought not to be intrusted to inexperienced persons, or to those who have not given evidence of their ability properly to accomplish the task they have undertaken.

"2. Preference should be given to those who are engaged in the laborious and difficult task of preparing complete monographs.

"3. As it would be illiberal to restrict the use of the specimens, and confine the study of them to persons who can visit Washington, the investigator should be allowed to take them to his place of residence, and to retain them for a reasonable time.

"4. The investigator must give assurance that he will prepare a set of type specimens for the Smithsonian museum, and will return all the duplicates, if required.

"5. In any publication which may be made of the results of the investigation, full credit must be accorded to the Institution for the facilities which have been afforded."

All these provisions on the part of the Institution were carried out as far as the circumstances would permit. The money available was insufficient for employing paid assistants to any considerable extent, and the Institution had the benefit of the voluntary assistance both of many recognized authorities in the several branches of science and of young students. The extent and importance of this aid cannot be overestimated. Collections which would have remained useless for years were rapidly classified by competent naturalists and separated into series, some to be reserved by the Institution, and others to be distributed to kindred scientific establishments and to colleges and schools.

The list of collaborators includes almost every name prominent in American natural history in the last half century. Nor

is this a matter for wonderment. The collections made by the exploring parties of the government in the twenty-five or thirty years following the founding of the Institution contained a great number of highly interesting forms of animals and plants previously unknown to science, and the naturalists in whose hands the various series were placed constantly enjoyed the delight of discovering these and making them known to the world. The boundaries of American natural history were widened in every direction. As regards vertebrates, Professor Baird remarked as early as 1856:

"Messrs. Audubon and Bachman describe about 150 North American species of mammals. This Institution possesses about 130 of these; and about 50 additional species have already been detected, although the examination of the entire collection has not yet been completed.

"Of North American birds, the Institution possesses nearly all described by Audubon, and at least 150 additional species.

"Of reptiles, the North American species in the Museum of the Smithsonian Institution amount to between 350 and 400. Of the 150 species described in Holbrook's 'North American Herpetology,' the latest authority on the subject, it possesses every genuine species, with one or two exceptions, and at least 200 additional ones. It has about 130 species of North American serpents for the 49 described by Holbrook.

"Of the number of species of North American fishes it is impossible to form even an approximate estimate, the increase having been so great. It will not, however, be too much to say that the Institution has between four and five hundred species either entirely new or else described first from its shelves."[1]

The scientific elaboration of the collections resulted in the publication of a great number of monographs and preliminary papers in the "Smithsonian Contributions to Knowledge" and

[1] "Smithsonian Report," 1856, page 60.

"Miscellaneous Collections," in the reports of the government surveys, and in the journals of learned societies at home and abroad. Many of the more comprehensive of these works remained as standards for a quarter of a century, and some have not been supplanted at the present day.

In this work no one labored with more enthusiasm or more success than Professor Baird, who, while carrying the burden of caring for the collections and planning for the exploration of new fields, prepared and published a series of works on North American vertebrates which commanded the admiration of naturalists throughout the world.

Side by side with the activities resulting in the increase of knowledge, the work of diffusing knowledge by the distribution of named natural history specimens was carried forward on an extensive scale. In the first twenty years of its history the Institution, according to the estimate of Professor Baird,[1] distributed more than one hundred thousand specimens, of which the larger part were identified and labeled.

In 1861 the charter of the National Institute expired and the various objects belonging to that organization became the property of the government and were transferred to the care of the Smithsonian Institution.

At this date, therefore, all the scientific and art collections belonging to the government and the collections made by the Institution itself were assembled in the Smithsonian building. They comprised many thousands of objects, and were administered by Professor Baird as Assistant Secretary of the Institution.

From the time the government came into possession, in 1841, of the collection made by the Wilkes Exploring Expedition Congress appropriated each year a small sum for the preservation of the objects accumulated in the Patent Office,

[1] "Smithsonian Report," 1865, page 85.

which money was disbursed at first by the National Institute, afterward by the Commissioner of Patents or the Joint Library Committee of Congress.

After these collections were transferred to the Smithsonian Institution in 1858, the appropriations for maintenance continued year by year, though small in amount. In 1858 the appropriation was $3,650; in 1859, and for eight years following, $4,000. The Institution never received any compensation for the occupancy of its building. As early as 1856,[1] Professor Henry expressed the opinion at an early day that the government might with propriety and advantage purchase the Smithsonian building from the Institution for housing the government collections "of natural history and the fine arts," but no action in that direction was ever taken.

When these collections were transferred from the Patent Office a series of new cases designed by Thomas U. Walter were erected in the main hall of the Smithsonian building for their display. Great progress has been made in museum methods in the last two decades, but the cases, arrangement, labeling, and taxidermy in the Smithsonian museum thirty-five years ago were probably as good as could be found in any scientific museum in the world at that time. The exhibition of many examples of a single species of animal or mineral, or of a single kind of ethnological or geological object, was not considered objectionable, and it was a common practice to mount and exhibit type specimens of animals. To such matters as the size of glass in cases, the color of woodwork and labels, the effect of different groupings of specimens, little attention was devoted. Indeed, the amount of money spent upon scientific museums was not sufficient for great refinement in display. Collections were exhibited for the satisfaction of the mature man of science, rather than the

[1] "Smithsonian Report," 1856, page 22.

youthful student and the layman. Yet these latter classes were neither purposely neglected nor did they complain of the methods in vogue.

It is with interest that we read the following comment by Professor Henry on the Smithsonian museum in 1861:

"During the past year Washington has been visited by a greater number of strangers than ever before since the commencement of its history. The museum has consequently been continually thronged with visitors, and has been a never-failing source of pleasure and instruction to the soldiers of the Army of the United States quartered in this city or its vicinity. Encouragement has been given them to visit it as often as their duties would permit them to devote the time for the purpose."[1]

In 1865 an event of much importance occurred. A fire broke out in the second floor of the Smithsonian building and destroyed the upper portions of the edifice. Many collections were entirely destroyed or injured beyond repair, among which the most important were Smithson's personal effects and cabinet of minerals, a large series of portraits of Indians painted and owned by J. M. Stanley, and the collection of physical instruments, including Hare's experimental apparatus and "the lens used by Priestley for the evolution of oxygen from the oxide of mercury, and by means of which the first distinct recognition of this elementary substance was effected."[2]

This event produced results affecting the museum in many ways. It called attention to the fact that the library of the Institution was kept in rooms not fireproof, and the transfer of the books to the Library of Congress was hastened, the space being subsequently occupied by the less valuable portions of the natural history collections. By the destruction of the Stanley portraits of Indians, which, though really an

[1] "Smithsonian Report," 1861, page 44. [2] "Smithsonian Report," 1865, page 18.

ethnological collection and only on deposit in the Institution, formed an important part of what (with frequent apologies) was called "the gallery of art," the attempts to form an art collection of merit received discouragement. The reconstruction of the building, made necessary by the fire, led to a new assignment of rooms for the ethnological collections. Previous to the fire the upper story had been used principally as a lecture-room, but the interest in lectures flagging for a time, it was determined after the reconstruction to place the ethnological collections in that portion of the building, but the transfer was not effected until several years later.

Though the formation of an art gallery was provided for in the organization of the Institution and a few art objects came into the possession of the government from time to time, Professor Henry took the position at an early day that with the funds available the establishment of an art collection worthy of the name was impossible. When Mr. W. W. Corcoran first took active steps toward the formation of the "Corcoran Art Gallery" in 1869, Henry recommended that art objects belonging to the Institution should be deposited therein. In 1873 the Board of Regents approved the plan, and in the following year a few paintings, sculptures, and engravings were transferred.

In the early days of the Institution the valuable collection of engravings made by Honorable George P. Marsh was purchased (the only large purchase by the Institution in the direction of art), and soon after the fire in the Smithsonian building it was transferred to the Library of Congress.

By 1874, therefore, the Institution had definitely abandoned all efforts toward the establishment of an art gallery, and though some few objects connected with the fine arts have come under its care in later years, they have never been assembled so as to form a proper "gallery."

In 1871 Congress established the United States Fish Commission and Professor Baird was placed at its head. The organization of the Commission on this basis had a most important effect upon the development of the National Museum in certain directions. The work of the Commission had to do largely with the natural history of fish and other aquatic animals, and in the course of a few years very large collections of marine life were deposited in the Museum. Later the work of the Commission turned toward the investigation of the phenomena of the deep sea, and in 1882 a sea-going steamer, the *Albatross*, was built, and extensive sounding and dredging operations in great depths were carried on.

The collections made during the progress of this work, and deposited in the Museum, were of the highest scientific interest, and the results already published by Goode, Verrill, Bean, Rathbun, Smith, and other naturalists have attracted worldwide attention. In many other ways, which cannot be detailed in the present connection, the work of the Commission was of direct and indirect benefit to the Museum, and the coöperation of these two governmental organizations has continued until the present.

Not many years after the organization of the Commission the question of the desirability of holding a great World's Fair to commemorate the hundredth anniversary of the Declaration of Independence began to be agitated in the country. The movement culminated in the organization of the Centennial Exhibition of 1876, held in Philadelphia. This event was destined to have a more important effect upon the National Museum than any which had occurred since the founding of the Smithsonian Institution.

The government determined that the various departments and bureaus should make extensive exhibits indicating their several functions, and on January 23, 1874, the President

appointed a government board to have general charge. The Smithsonian Institution was represented by Professor Baird. In the first plans of the board the National Museum exhibit was included under that of the Institution, and the Fish Commission apparently under the Interior Department. They included also an item of $200,000 for an exhibition building which should be "capable of removal to Washington after the close of the Exhibition, to be used as a National Museum at the capital of the nation."[1] Congress, however, saw fit to modify these plans and provided for the erection of a general government building, to be paid for *pro rata* from the appropriations of the several departments and bureaus, and to be sold at the close of the Exhibition. An appropriation of $67,000 was made for the Smithsonian Institution, and of $5000 for the Fish Commission, the provision for the National Museum being included in the former. When the several officers of the Board began to examine the situation in detail it became apparent that different bureaus would duplicate one another's exhibits unless some compromise were made. Accordingly the exhibits of the Institution, the National Museum, and the Fish Commission were merged into one comprehensive exhibit; while, on the other hand, the National Museum coöperated with the Indian Bureau of the Interior Department in an exhibit representing North American anthropology. The combined exhibit was divided into five sections — Smithsonian Activities, "Animal Resources," Fisheries, Mineral Resources, Anthropology.

In the preparation of the exhibits of "animal resources" and fisheries Professor Baird (then "Curator of the National Museum") had the assistance of G. Brown Goode ("who held the position of Assistant Curator of the National Museum"), Tarleton H. Bean, and H. C. Chester; in ethnology, Charles

[1] "Smithsonian Report," 1875, page 59.

Rau, Edward Foreman, and F. H. Cushing; in mineral resources, William P. Blake and Thomas Donaldson.

When the idea of holding a great exhibition under the government was first put forth, both Secretary Henry and Professor Baird foresaw that the effect on the National Museum must be of the greatest moment. The objects purchased and exhibited by the government of the United States would find their final resting-place in the Museum, and many foreign governments and private exhibitors would doubtless present their exhibits to the United States, with the result that they also would find their way into the Museum.

"The results of the operations of the Institution in connection with the Centennial Exhibition," wrote Professor Henry in 1875, "will probably have a much greater effect on the future of the establishment than is at first sight apparent. The large number of specimens which have been collected by the several Departments of Government and by the Institution itself in view of this Exhibition will greatly increase the contents of the National Museum, and if we add to these the specimens which will be presented by foreign powers, of which we have already had intimations, the number will be swelled to an extent far beyond the capacity of the present building to contain them, and an additional edifice will be required for their accommodation.

"In the consideration of this matter, the questions will arise whether the building required shall consist of an extension of the present Smithsonian edifice, or an entirely separate building; and these questions will involve another, viz., whether it is advisable to continue, at least without some modification, the connection which now exists between the Smithsonian Institution and the National Museum.

"The Museum is destined to an extension far beyond its present magnitude. It is an object of much interest to all who visit the National Capital, and is of great value as ex-

hibiting the natural resources of the country, as well as a means of public education."

Professor Baird, as Exhibition representative of the Institution, wrote in the Report of the same year as follows:

"It will, however, be readily understood that the Smithsonian Building will be entirely inadequate to accommodate this collection on its return from Philadelphia, especially as even now it is overcrowded and packed from top to bottom with thousands of boxes, for the proper exhibition of the contents of which there is no space or opportunity at the present time. It is to be hoped that action at an early day will be taken by Congress looking toward a proper provision for this emergency, especially when it is realized that the materials are thus available for a National Museum that shall be equal, in its extent and completeness and in its educational advantages, to that of any nation in the world.

"The collections made directly through the Government appropriations will also be very largely supplemented by the donation of series of American and foreign exhibitors, a very large proportion of which will be placed at the disposal of the United States Government."

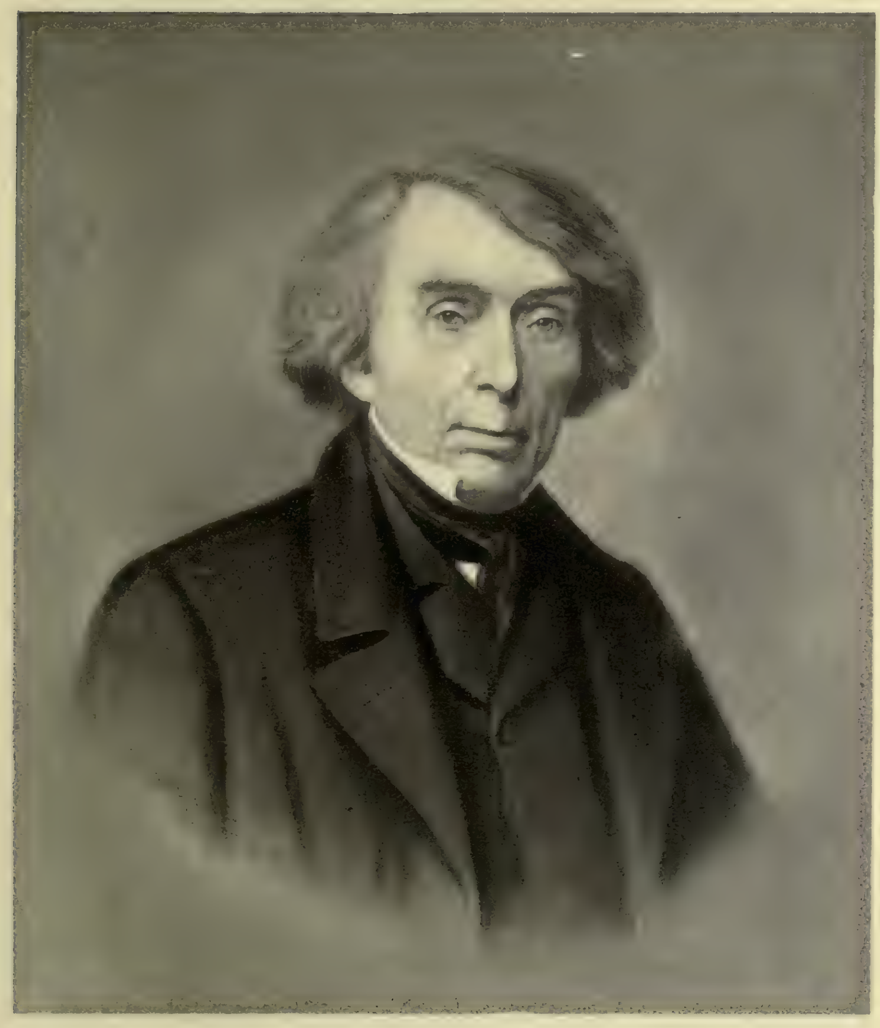
The anticipations of Henry and Baird were fully met. In the Report for the Centennial year Professor Baird wrote:

"At no period in the history of the National Museum, from the time when it was organized to the present, has the increase been so great as during the year 1876."[1]

After referring to the accessions from the government exhibits, he remarks:

"In addition, however, to the sources of increase to the Museum during the years 1875 and 1876, mentioned above, still another presented itself of perhaps even greater pro-

1 "Smithsonian Report," 1876, page 38.



ductiveness, viz., acquisitions from foreign exhibits. With scarcely an exception, the best and most important of these were presented to the United States at the close of the exhibition, embracing, as they did, many complete series of objects, illustrating the geology, metallurgy, the ethnology, and the general resources of all nations. Of about forty governments and colonies, the choicest of the exhibits of thirty-four were presented to the Smithsonian Institution for the National Museum, the remainder either having nothing to give or being restricted in the disposal of their articles.

"It was, however, not from foreign commissions alone that collections were received by the Institution. Several entire State exhibits and many belonging to private parties were also added to the general increase. Nevada, Montana, and Utah presented the whole of their mineral exhibits, while partial collections were received from several other States and Territories."

The Regents of the Institution submitted a memorial to Congress the same year (1876) asking an appropriation of $250,000 for a building for the National Museum. A bill was introduced, but failed of passage that year, and it was not until 1879 that the amount asked for was provided.

As soon as the law was enacted a building commission appointed by the Regents of the Institution was organized, consisting of the resident members of the executive committee of the Institution (Honorable Peter Parker and General William T. Sherman) and Secretary Baird. General Sherman was chosen as chairman and General M. C. Meigs was invited to act as consulting engineer.

The commission selected the firm of Cluss & Schulze, whose design for the building had been approved by Congress, as superintending architects, and received the benefit of the advice of Mr. Edward Clarke, architect of the Capitol.

The erection of the building was begun April 17, 1879, and

completed in 1881. In design the structure is of the type commonly employed for exhibition buildings, being entirely open above the ground floor. It covers a space of two and a third acres. On account of the relatively small amount appropriated for the building and the enormous growth of the national collections, it was necessary to use building materials of low cost and to cover in as much space as possible. The building is regarded as one of the cheapest of its size ever erected. While admirably adapted in most respects for the purpose for which it was built, it does not, of course, present, either externally or internally, an appearance as pleasing or dignified as would have resulted from the use of a more expensive system of construction and more costly materials.

While the building was under construction, Congress decided that the United States Government should be represented at the Berlin Fisheries Exhibition of 1880 by the Fish Commission. Professor Baird, then both Secretary of the Institution and Fish Commissioner, appointed G. Brown Goode, the Curator of the National Museum, as his deputy at the exhibition. By this fortunate combination of circumstances, Doctor Goode, the working head of the National Museum, was afforded an opportunity to study the museums of Germany and other parts of Europe, and brought home with him a knowledge of the most approved methods of installation of collections, labeling, and storage which was invaluable. Far more fortunate was it that the Museum at this critical time in its history had as its curator a man of such surpassing merit as the lamented editor of this volume. Gifted with a philosophical mind, a profound love of nature, a marvelously retentive memory, and untiring energy, he acquired a range of knowledge and a grasp of affairs which astonished his associates, while his modesty, gentleness, and love of fair play attracted to him and bound to his service men of the most

diverse capacities and opinions. His genius was known to Secretary Baird, but hitherto he had not found a sufficiently wide field for the exercise of his powers. The reorganization of the Museum afforded an opportunity, and Baird gave him free scope for the development of his plans, aiding him as no one else could have done, from the stores of a lifetime of experience along the same lines.

Out of the heterogeneous materials accumulated by the government, especially as a result of the Centennial Exhibition, Doctor Goode organized, under the approving guidance of Secretary Baird, a public museum of wide scope, attractive, instructive, orderly, and full of the elements of life. He elaborated with the greatest pains a philosophical and comprehensive classification for the collections of the Museum, and planned a complete reorganization of the staff of curators and assistants. He devised an entirely new series of cases and other fixtures, for the installation of both the collections exhibited to the public and those reserved for the use of investigators, adopting the best features then developed in European museums, and adding many of his own invention.

This regeneration of the National Museum soon made itself felt in similar organizations throughout the United States and in other parts of the world, and the methods of installation and labeling employed in Washington have been widely copied.

The influence of the National Museum has not, however, stopped here. Already at the Berlin Fisheries Exhibition of 1880, with the experience gained during the Centennial Exhibition, Doctor Goode was able to secure for the United States Fish Commission and the National Museum the Emperor's prize for the highest excellence of display. Not satisfied with this recognition, and always aiming to advance, he endeavored to install the exhibits of the Institution and Mu-

seum at later foreign and domestic exhibitions, in accordance with the best museum methods. As a result the exhibits of the Institution always won high praise, and it is not too much to say that the work of the National Museum in this direction has had a powerful influence in revolutionizing exhibition methods in America.

Since the Centennial Exhibition of 1876, few years have passed in which the Museum has not been engaged in preparing for a public exposition of greater or less magnitude. It made displays at London in 1883, at Louisville in 1884, at Minneapolis in 1887, at Cincinnati and Marietta in 1888, at Madrid in 1892, at Chicago in 1893, and at Atlanta in 1895. The necessity of carrying on exhibition work outside of Washington has affected the National Museum in many ways. Probably no other great permanent museum in the world has had constantly before it the problem of guarding its treasures from deterioration, and at the same time transporting no inconsiderable portion of them thousands of miles and displaying them under the ordinarily unfavorable surroundings of temporary exhibitions. The advantages lie in the direction of making the work of the Museum known to the people of the Republic and the world at large, and securing new objects with which to fill out the deficiencies in its various collections. The disadvantages are found in damage done to objects in the collections by breakage or otherwise, the interruption of the regular Museum work, and the dissipation of the energies of the scientific officers; for a museum, like any other permanent institution, requires abundant time and uninterrupted activity for its best development, and does not flourish in the midst of commotion and excitement.

Thus far I have considered the National Museum in its historical aspects. It remains to explain briefly its function

and aims, and to mention the most notable objects in its collections.

It will be perceived, from the statements already made, that the Museum is essentially a natural development springing from the activities of the government, growing with their growth, and expanding with their expansion. It had its origin in the great naval exploring expedition which the government organized in the early part of the century, and found an important expansion in the long series of topographical surveys of the public domain, and geological surveys of later years. The scientific investigation of the primary industries — agriculture, fisheries, and mining — by the government has also resulted in large additions to the Museum. Finally, the desire on the part of the government that the people should gain a better understanding of its practical workings, through representative displays of processes and objects in the great public exhibitions, has broadened the activities and increased the wealth of the Museum, both directly and indirectly; — directly, because the Museum has need to bestir itself to bring together and arrange exhibits which will be acceptable to the public; indirectly, because the participation of the government of the United States often leads other governments to participate, and the exhibits of these, in greater or less proportion, are ultimately presented to the United States for its National Museum.

The field of activities of the government has had a strong influence on the character of the collections of its National Museum. While European governments have been engaged in exploring new regions and founding colonies in distant sections of the globe, that of the United States has confined its attention almost exclusively to North America. The collections of the National Museum, therefore, are predominantly North American. Leaving out of consideration the

important foreign collections of a few early expeditions, and those resulting from the deep-sea investigations of the United States Fish Commission, the additions in this direction have chiefly come from the activities of private explorers, by gift of foreign governments at expositions, by exchange of specimens, and only in a few instances by purchase.

In the organic law of the Smithsonian Institution already cited it is provided that

> "In proportion as suitable arrangements can be made for their reception, all objects of art and of foreign and curious research, and all objects of natural history, plants, and geological and mineralogical specimens belonging, or hereafter to belong to the United States, which may be in the city of Washington, in whosesoever custody the same may be, shall be delivered to such persons as may be authorized by the Board of Regents to receive them, and shall be arranged in such order and so classed as best to facilitate the examination and study of them."

In the act of June 30, 1880, making appropriations for the sundry civil expenses of the government, it is enacted that "all collections of rocks, minerals, soils, fossils, and objects of natural history, archæology, and ethnology, made by the Coast and Interior Survey, the Geological Survey, or by any other parties for the government of the United States, when no longer needed for investigations in progress, shall be deposited in the National Museum."[1]

In the same year, as we have said, Congress appropriated money "for a fire-proof building, *for the use of the National Museum.*"

As may be seen from the statutes cited, the National Museum is the recognized depository for all objects of scientific and artistic interest and value which come into the possession

[1] Statutes United States Forty-fifth Congress, third session, chapter 182, page 394.

of the government. Its function is to preserve these treasures perpetually and to administer the collections in such a manner as to render them of the highest service to research and education. In pursuance of these ends it exhibits a portion of the collections for public inspection and instruction; another portion it assembles in laboratories for the use of investigators. Out of the surplus accumulations it selects series of specimens for distribution to educational institutions, and it encourages publications which will make its treasures known to the world. Of these latter activities it will be necessary to speak somewhat more in detail before closing, and I will return to them presently. It is desirable to point out here the fact, which will become evident to any one upon reflection, that an institution such as the National Museum, with its facilities for investigation and its corps of trained specialists, soon becomes a center of intellectual activity, attracting to itself students and *savants*, and being called upon to impart technical information and advice. In these lines lies no inconsiderable part of its labor and usefulness.

It is to be said further that the Museum of to-day, owing in part to a natural development, and in part to the labors of a few advanced leaders, among whom none have rendered more important service than the late Doctor Goode, is no longer content with a passive existence, but strives, by the arrangement of its collections, by its labels, its hand-books and other publications, and its lectures, to impart instruction of a definite character and in definite lines. It assembles great collections of natural objects and treasures of art not merely to satisfy idle curiosity, but to diffuse knowledge among men. Thus it allies itself to the university and the library, and must be counted among the chief agencies for the spread of culture.

To describe in detail all the more important objects in the National Museum would require more space than can be devoted to such an enumeration in this volume, but it will be of interest to point out the chief excellences of the collections and to mention some of the treasures.

The collections are at present divided among the following Departments and Sections:

Zoölogical Departments: Mammals, Birds (with a Section of Birds' Eggs), Reptiles and Batrachians, Fishes, Mollusks, Insects, Marine Invertebrates (with a Section of Parasitic Worms), Comparative Anatomy.

A Botanical Department.

Geological Departments: Geology, Mineralogy, and Paleontology.

Anthropological Departments: Prehistoric Anthropology, Ethnology (with a section of American Pueblo Collections), Oriental Antiquities.

A Department of "Arts and Industries," with the following sections at present: Historical Relics, Transportation and Engineering, Naval Architecture, Physical Apparatus, Electrical Collections, Technological Collections, Materia Medica, Forestry, and Graphic Arts.

The Department of Mammals comprises the collection of the Wilkes Exploring Expedition and of the numerous geographical and geological surveys of the public domain, including the type-specimens of species described by Baird in his great work on North American mammals, and numerous types of J. A. Allen, Elliott Coues, Harrison Allen, and other American naturalists. The collections from the Mexican boundary recently made by Doctor E. A. Mearns, U. S. A., are large and of high scientific value.[1]

[1] The very extensive series of North American mammals made by the United States Department of Agriculture under Doctor C. Hart Merriam, the finest ever assembled, is deposited in the Museum building and catalogued in its registers.

A series of casts of porpoises and other cetaceans, including a young humpback whale, forms a unique feature of the Department.

The representation of foreign mammals, though deficient in many directions, includes a considerable number of type-specimens, and some important local collections, chief among which are those from German East Africa and from Kashmir and Eastern Turkestan, made and presented by Doctor William L. Abbott.

The collection of skulls of North American mammals is probably unrivaled elsewhere in extent, and the Department also contains a large alcoholic series.

Of the Department of Birds, the Curator, Mr. Robert Ridgway, writes:

"Among the most important collections and single objects contained in the Department of Birds are the following:

"(1) The collections made by the Wilkes Exploring Expedition, the various Pacific Railroad Surveys, the Mexican Boundary Survey, the Geological Exploration of the Fortieth Parallel, the Geological Survey of the Territories, Geographical Surveys West of the One Hundredth Meridian, the United States Astronomical Expedition (Gilliss), and various other government expeditions.[1]

"(2) The collection made by Colonel A. J. Grayson in Western Mexico, including the Tres Marias and Revilla-Gigedo Islands; collections made by Professor F. Sumichrast on the Isthmus of Tehuantepec, and by Professor C. Sartorius in the State of Vera Cruz, Mexico; collections made by F. A. Ober in the various islands of the Lesser Antilles.

"(3) The collections made by the United States Fish Commission during a cruise of the steamer *Albatross* around Cape Horn and in the Bahamas.

[1] The valuable collections of birds made by the United States Department of Agriculture under the direction of Doctor C. Hart Merriam in the United States and Mexico are deposited in the Museum building, as in the case of the mammals.

"(4) Specimens from Audubon's collection, among them a considerable number of types of his new species, that is, specimens from which the descriptions and colored plates in his great work were taken. These formed part of Professor Baird's private collection, to whom they were given by Mr. Audubon.

"(5) The private collection of Professor Baird, numbering nearly 4000 specimens, which formed the nucleus, or beginning, of the present national collection.

"(6) Other private collections donated to the National Museum.

"(7) The collections made by Doctor William L. Abbott in Eastern Africa, Madagascar, etc., generously presented to the National Museum and embracing a very large number of species entirely new to the Museum collection, many of them being new to science. These collections of Doctor Abbott, moreover, represent practically all that the Museum possesses from the countries named.

"(8) The collection of several thousand specimens from various parts of the world, presented by Mr. A. Boucard, of Spring Vale, Isle of Wight, England.

"(9) Extinct Birds: Great Auk (one specimen), Labrador Duck (several), Guadelupe Caracara (good series, old and young), and Philip Island Parrot, the latter purchased for the Museum by Doctor William L. Ralph, of Utica, New York.

"(10) Very rare species, or those nearly extinct, as the Carolina Paroquet, Ivory-billed Woodpecker, Black-capped and Jamaican Petrels, Hawaiian Coot, Cuban Macaw, Peale's Sandpiper (several specimens, the only ones known to exist in collections), and numerous other species.

"(11) Unique types, such as Fisher's Petrel, Townsend's Bunting, Cooper's Sandpiper, Cooper's Hen-Hawk, Riker's Woodhewer.

"The National Museum collection of North American birds is by far the most complete in existence, and is the basis of every important work on North American birds since Audubon's time. That of the birds of the West Indies is also the most important, although exceeded greatly in number by that

of Mr. C. B. Cory, now the property of the Field Columbian Museum, in Chicago, Illinois. That of Central American and South American birds is exceeded in extent and value only by the British Museum's series of birds from the same region, and has been freely used by Messrs. Sclater, Salvin, Godman, Count von Berlepsch, and others in their various publications on neotropical birds, and is also largely the basis of Professor Baird's 'Review of American Birds.'

"Museums throughout the world have been supplied with American birds by the United States National Museum, and the existing specimens of several species, such as the Roseate Gull, Greenland Redpoll, and several Alaskan species, have mainly, — in some cases exclusively,— been distributed by the National Museum.

"It can safely be said that no collection of birds in the world compares with that of the United States National Museum in value or importance as a basis for scientific investigation already accomplished or yet to be done, since as many species as possible, with the facilities at command, are represented by large series of specimens from all parts of their geographical range, and of all known variations dependent on climate, sex, age, or other circumstances.

"The unparalleled collection of North American birds' eggs in the United States National Museum is the result of many years' growth. In the early years of the Institution Professor Baird interested the naturalists of the various government surveys and members of the Hudson Bay Fur Company in the subject, and from them (and especially the latter) thousands of eggs were received. Mr. R. McFarlane[1] was particularly active, and with him were associated B. R. Ross, James Lockhart, John Reid, M. McLeod, A. McKenzie, and others, who sent not only eggs, but large collections of other kinds. The Institution sent Robert Kennicott to Arctic America in 1859, where he remained three years, collecting the natural productions of the region, and with them many eggs of Arctic birds.

[1] See his report in "Proceedings of the United States National Museum," Volume XIV, pages 413–446.

"Naturalists visiting Alaska and Labrador also made large contributions to the oölogical collections. The eggs of the rare Northern water-birds and waders so difficult to obtain for private collections were thus sent (often in large series) to the Institution.

"In 1884 Major Bendire added to the already large collection his unrivaled series of eggs of Western birds, obtained during twenty-five years of duty in the Territories. This collection numbered eight thousand or more beautifully prepared specimens. From that time till his death Major Bendire was untiring in his efforts to obtain the desiderata of the collection. More recently Doctor William L. Ralph, of Utica, New York, has presented his magnificent collection of eggs to the Institution, and is now actively engaged in filling gaps in the series.

"To mention specifically all the rarities in the North American series of the oölogical department would be an almost endless task; a few of the more important ones are the following:

"Great Auk, 1 egg; Heermann's Gull, 2 eggs; Craveri's Murrelet, 2 eggs; Jabiru, 1 egg; Purple, Aleutian, Coues's, Baird's, Pectoral, White-rumped, and Curlew Sandpipers; Sanderling, 2 specimens (McFarlane); Heath Hen, one specimen; Passenger Pigeon, about thirty eggs; California Vulture, 1 egg; Harlan's, Krider's, and Short-tailed Hawks; Peale's, Richardson's, and Aplomado falcons; Elf, Flammulated, and Californian Pigmy Owls; Carolina Paroquet; Ivory-billed Woodpecker; White-throated and Vaux's Swifts; Clarke's Nutcracker, several eggs; Western Evening-Grosbeak; American and Mexican Crossbills; Pribilof Snowflake, several eggs. Among the rare warblers may be mentioned: Brewster's, Virginia's, Lucy's, Cape May, Olive, Sennett's, Grace's, Townsend's, Hermit, Golden-cheeked, Gray, and Connecticut Warblers; Rio Grande and Belding's Yellow-throats; Red-faced Warblers.

"Of foreign eggs may be mentioned those of the Kamtschatkan Sea Eagle and the Quesal; also various series of eggs, like those collected by Doctor Jerome H. Kidder on Kerguelen

Island, Doctor William L. Abbott in Africa, Seychelles Islands, Asia, etc. On some of these reports have been made."[1]

Of the Department of Reptiles and Batrachians, the Curator, Doctor Leonhard Stejneger, remarks:

"The distinctive characteristic of the reptile collection in the Museum is in the completeness with which it illustrates the geographical distribution and morphology of the species inhabiting North America. In this respect it stands unrivaled. As the depository of the types of the species described by Baird, Girard, Kennicott, Cope, and other distinguished American herpetologists it also takes first rank.

"The importance of the individual collections must therefore be judged with reference to their richness in such types and the advance in our knowledge of the reptiles and batrachians of this continent that has ensued. The collections which have undoubtedly contributed most in these respects are those of the Pacific Railroad Surveys, the first Mexican United States Boundary Survey, and the Wilkes Exploring Expedition."

The collections of fishes are almost exclusively North American, with one notable exception in the case of the deep-sea fishes dredged by the United States Fish Commission steamer *Albatross* in the North Atlantic and North Pacific. The latter collection is of equal importance with that of the *Challenger* expedition, if it does not surpass the same, and formed the basis of the recent work of Doctor Goode and Doctor Bean on "Oceanic Ichthyology."

The Department contains the most extensive collections of fresh-water and littoral fishes of the United States anywhere

[1] "Contributions to the Natural History of Kerguelen Island, made in connection with the American Transit of Venus Expedition, 1874–'75," being Bulletin No. 3, United States National Museum. Also "Description of Nests and Eggs of Some New Birds, collected on the Island of Aldabra, Northwest of Madagascar, by Doctor W. L. Abbott." Proceedings of the United States National Museum, Volume XVII, 1894, pages 39–41.

assembled, consisting chiefly of the great series formed by the United States Fish Commission, supplemented by the collections of many American naturalists. The collection of Alaskan fishes is very large, and is not extensively duplicated elsewhere.

The series of fishes collected in connection with the Pacific Railroad Surveys and the first Mexican Boundary Survey are of special importance as containing the types of a large proportion of the species of the middle and western United States. They have been supplemented in recent years by important series collected under the auspices of the Fish Commission and by private collectors.

The Department contains also many single specimens of great value, which have been made the basis of new families and genera.

Regarding the Department of Mollusks, Mr. William H. Dall, the Honorary Curator, writes as follows:

"The collection of mollusks was founded primarily upon the specimens gathered by the United States Exploring Expedition under Wilkes during 1838–'42, which formed the types of the folio volume on the mollusks and shells by Doctor A. A. Gould, included in the series of United States Exploring Expedition reports published by Congress. To these were added the types of the mollusks of the North Pacific Exploring Expedition under Ringgold and Rodgers, collected by Doctor William Stimpson, and described by Gould. The collections were very rich and valuable, for the time, but underwent serious vicissitudes before and after being received by the Smithsonian Institution previous to the organization of the museum, so that the series as it now exists is by no means complete. Nevertheless these shells form an interesting and important portion of the collection.

"Next in point of number and value comes the collection,

especially of Unionidæ, given by Doctor Isaac Lea, and subsequently enriched by his son-in-law and daughter, the Reverend and Mrs. L. T. Chamberlain. This collection is, in its specialties, the freshwater mussels of the world, unrivaled for extent and value, comprising an enormous number of types and having full data in relation to the habitat, etc., in nearly every case.

"Almost as important for the mollusks of Great Britain, Northern Europe, the Mediterranean, and especially for the various deep-sea dredging expeditions sent out under British auspices before the *Challenger* expedition, is the Jeffreys collection, purchased from Doctor J. Gwyn Jeffreys, and comprising the results of nearly half a century of active collecting, exchanging, and purchase—in all some 25,000 lots of specimens, by far the most important and complete series of British shells in existence, and forming the basis of some hundred publications.

"The fauna of West America, both littoral and deep-sea mollusks, is represented by the combined collections of Robert E. C. Stearns, William H. Dall, the United States steamer *Albatross* of the Fish Commission, the Arctic cruisers of the United States Revenue Marine, and many private donations, in all representing the most complete existing representation of the fauna, with full data in nearly every case.

"The fauna of the east coast of North America is represented by the unrivaled collections of the United States Fish Commission, augmented by a series of those of the *Blake* and many private collectors in the West Indies and on our southern coast.

"The land and freshwater shells of North America, apart from the freshwater mussels, are represented by the best existing collection derived from many sources, including types of Binney and Bland, Lea, Lewis, Dall, Stimpson, and many others.

"To sum up, the collection of mollusks has the best series in the world, supplied with the fullest data, in the modern sense, of the land, freshwater, shore, and deep-sea mollusks of North America, the Arctic regions, the North Atlantic and

Pacific and the British Islands. In the total number of specimens, the collection is the largest in the world, including over six hundred thousand specimens of dry shells and five thousand jars of alcoholic molluscan material. The collection of Cenozoic fossil shells comprises the largest existing series of the tertiary fauna of the United States; and probably the largest series of Antillean tertiary shells in any museum, though much remains to be done in naming and classifying the fossil material.

"It may be said without fear of contradiction, that for the regions mentioned, the Department of Mollusks is unrivaled, not only in the amount and variety of material it contains, but especially in the full and correct data recorded in respect to the specimens, and which gives to them a really scientific value, which is wanting in most of the great collections of the world, which were mostly made at a period when the importance of such data was not fully recognized. No other collection contains nearly as many American and British type specimens; and only the British Museum rivals ours in the number of species represented from the whole world. No other collection has so large a representation of deep-sea mollusks and brachiopods, for the study of which the National collection is indispensable."

Of the Department of Insects, Doctor L. O. Howard, the Honorary Curator, writes:

"Taking the collection as a whole, and aside from the consideration of the individual collections of which it is composed, I should say that its most important features are, first, the rapidly accumulating number of types in all orders, amounting already to more than thirty-five hundred species; and second, the biologic features of the collection, due largely to the fact that the original deposit by Doctor Riley was mainly biologic in its character, and to the further fact that the biologic accumulations of the United States Department of Agriculture for seventeen years, which have been very great, are now in the possession of the Museum.

"The subjoined statement refers to the source of the different collections now brought together. Looking at the collection as a whole, however, the departments which stand out conspicuously are (*a*) the collection of North American Noctuidæ (probably the most complete in existence), (*b*) the collection of Parasitic Hymenoptera (undoubtedly the largest collection of bred specimens in the world), (*c*) the Orthopterous family, Acrididæ, (*d*) the Homopterous families Coccidæ, Aphididæ, and Psyllidæ (without doubt the largest accumulation of North American species), (*e*) the Dipterous families Syrphidæ and Empidæ, (*f*) the collection of Myriopoda.

"The Department is at present in excellent working condition. It contains a very great amount of material in all orders, and in many unusual directions surpasses any collection in the country. Among others the following are of special interest:

"1. The large collection, in all orders, of Doctor C. V. Riley.

"2. All of the material gathered during the past eighteen years by correspondents, field agents, and the office staff of the Division of Entomology, United States Department of Agriculture.

"3. The greater part of the collection of Asa Fitch.

"4. The large collection, in all orders, of G. W. Belfrage.

"5. The collections in Lepidoptera and Coleoptera made by Doctor John B. Smith down to 1889, together with the types of the Noctuidæ since described by Doctor Smith.

"6. The collection of Lepidoptera of O. Meske.

"7. The collection of Lepidoptera of G. Beyer.

"8. The collection of Coleoptera of M. L. Linell.

"9. The bulk of the collection, in all orders, of H. K. Morrison.

"10. The collection of Diptera of Edward Burgess.

"11. The type collection of Syrphidæ made by Doctor S. W. Williston.

"12. The collection of Ixodidæ of Doctor George Marx.

"13. The collection of Myriopoda of C. H. Bollman.

"14. Sects of the neotropical collections of Herbert H. Smith.

"15. The collection of Hymenoptera of William J. Fox.

"16. The collection of Tineina of William Beutenmüller.

"17. The large Japanese collection, in all orders, of Doctor K. Mitsukuri.

"18. The African collections, in all orders, of Doctor W. L. Abbott, William Astor Chanler, J. F. Brady, the Eclipse expedition of 1889–90 to West Africa, and of several missionaries.

"19. The large collection from South California of D. W. Coquillett, in Coleoptera, Hymenoptera, Lepidoptera, and Orthoptera.

"20. The Townend Glover manuscripts and plates.

"In addition to this material, there are minor collections which have been the result of the work of government expeditions, or are gifts from United States Consuls and many private individuals."

The most beautiful, and in many respects the most important, of the numerous series in the Department of Marine Invertebrates is the collection of corals made by the United States Exploring Expedition, and described by Dana. It includes many types of new forms. The great deep-sea collections from the North Atlantic and North Pacific made by the United States Fish Commission deserves notice; as do also the exhaustive collections from the New England coast and the Fishing Banks, and from the west coast of Alaska, received from the same source. All the collections are very rich in the types of new species and higher groups.

Among the notable specimens in the Department of Comparative Anatomy should be mentioned the skulls and partial

skeletons of the great extinct Arctic Seacow (Rytina) ; several skeletons of huge Galapagos Tortoises ; and an unrivaled series of bones of the Great Auk. The collection is rich in skulls and skeletons of the various species of porpoises.

In the Department of Geology the following series and separate objects are pointed out by Doctor George P. Merrill as deserving special mention :

"1. The Leadville (Colorado) collections of rocks and ores, comprising some three hundred and eighty specimens, illustrating the work of S. F. Emmons and Whitman Cross.[1]

"2. The Washoe collections, comprising one hundred and ninety-eight specimens as selected and studied by George F. Becker.[2]

"3. The collections of the Fortieth Parallel Survey. These comprise some three thousand specimens of eruptive and sedimentary rocks collected by members of the Fortieth Parallel Survey, under the direction of Clarence King, in 1867–73. The eruptive rocks of the series were described by Professor Ferdinand Zirkel.[3]

"4. The Hawes collections. These comprise some three hundred and fifty specimens of eruptive altered rocks, representing in part the work done by Doctor Hawes in connection with the New Hampshire surveys.[4] It also includes the small fragments described in his paper[5] on the Albany granites and their contact phenomena.

"5. The Pacific Slope Quicksilver collections. These comprise several hundred small specimens (mostly 4 × 6 cm.), rocks and ores from the quicksilver regions of the locality above noted, as collected and described by G. F. Becker[6]

1 Emmons, Samuel Franklin. "Geology and Mining Industry of Leadville, Colorado, with Atlas." Monograph XII of the United States Geological Survey, 1886.

2 "Geology of the Comstock Lode and the Washoe District, with Atlas." Monograph III of the U. S. Geological Survey, 1882.

3 "Microscopic Petrography." United States Geological Explorations of the Fortieth Parallel, Volume VI, 1876.

4 "The Geology of New Hampshire." Concord, 1878, Volume III, Part IV.

5 *American Journal of Science*, 1881, Volume XXI, pages 21–32.

6 Monograph XIII of the United States Geological Survey, 1886.

and colleagues in 'Geology of the Quicksilver Deposits of the Pacific Slope.'

"6. Pigeon Point collections. These comprise four hundred specimens illustrating various contact phenomena as occurring at Pigeon Point, on the north shore of Lake Superior, and as described by Professor W. S. Bailey in a bulletin [1] of the United States Geological Survey.

"7. Menominee Valley and Marquette River collections. These comprise two hundred and fifty-four specimens illustrative of the dynamic metamorphism of eruptive rocks as described by Professor George H. Williams. [2]

"8. The Eureka (Nevada) collection, comprising some five hundred and six specimens, rocks and ores, as studied and described by Arnold, Hague,[3] Whitman Cross, and J. S. Curtis.[4]

"9. The Cripple Creek (Colorado) collections. These comprise some eight hundred specimens of rocks and ores. The material studied by Whitman Cross and R. A. F. Penrose and described in their report on the 'Geology and Mining Industry of the Cripple Creek District.'[5]

"10. The Silver Cliff collections, comprising three hundred specimens of rocks and ores. The collection upon which is based the report by Whitman Cross and R. A. F. Penrose.

"11. The Tenth Census collection of Building and Ornamental Stone comprises some three thousand specimens, mainly in the form of four-inch cubes, and two thousand thin sections.[6] These formed the basis of the results given in 'The Collection of Building and Ornamental Stones; a Handbook and Catalogue.'[7]

1 "The Empire and Sedimentary Rocks on Pigeon Point, Minnesota, and their Contact Phenomena." 1893. Bulletin, No. 109.

2 "The Greenstone Schist Areas of the Menominee and Marquette Regions of Michigan." 1890. Bulletin No. 62 of the United States Geological Survey.

3 Hague, Arnold. "Geology of the Eureka District, Nevada, with Atlas." 1892. Monograph XX of the United States Geological Survey.

4 Curtis, Joseph Story. "Silver-lead Deposits of Eureka, Nevada, 1884." Monograph VII of the United States Geological Survey.

5 Sixteenth Annual Report of the United States Geological Survey, Part II, 1894–95.

6 Merrill, George P. Special Reports on Petroleum, Coke, and Building Stones, Tenth Census of the United States, 1880, Volume X.

7 Report United States National Museum, 1886, page 277.

"12. The Tenth Census collection of Iron Ores, comprising some two thousand two hundred hand specimens and five hundred and six thin sections. This formed the basis of Professor Raphael Pumpelly's report.[1]

"13. The collection illustrating Kirkaldy's experimental inquiry into the mechanical properties of Fagersta steel.

"14. Collections from the Archæan Division of the United States Geological Survey made in Vermont and Massachusetts, and forming the basis of the petrographic work to be published in a forthcoming monograph.[2]

"Among the materials of greatest historical importance may be mentioned:

"(*a.*) A mass of iron smelted by members of the Frobisher expedition during their stay at Frobisher Bay in 1578.

"(*b.*) A piece of metallic tin smelted by Doctor T. C. Jackson in 1840 from ore found at Jackson, Carroll County, New Hampshire, and believed to have been the first tin smelted in America.

"(*c.*) The first steel car axle made in America and bent cold.

"(*d.*) Copper medal. Struck from the first copper produced in Colorado in 1866.

"(*e.*) Placer gold. First gold discovered in California, from tail-race two hundred yards below the mill, panned by J. W. Marshall on the evening of the 19th and 20th of January, 1848. Marshall's Claim, Sutter's Mill, Coloma, El Dorado County, California.

"(*f.*) Sample of petroleum from the first flowing well in the United States. Drilled in 1829 near Burkesville, Kentucky.

"Among the more striking collections of the exhibition series may be mentioned the one illustrating limestone caverns and associated phenomena. This includes not only a large and variegated series of stalagmitic and stalactitic min-

[1] Report on the Mining Industries of the United States, with special investigations into the iron resources of the Republic, and into the cretaceous coals of the Northwest. Volume xv., Washington, 1886.

[2] See also Thirteenth and Fourteenth Annual Reports of the United States Geological Survey.

erals, but also representative forms of animal life such as inhabit caverns. The collection as a whole is doubtless the most complete and systematic of its kind in any museum in the world.

"In the economic section are very full and systematic collections illustrating the mineral resources of the United States, arranged geographically, and also a systematic series in which minerals of the same nature and from world-wide sources are arranged by kinds. This collection comprises probably not fewer than ten thousand specimens."

Mr. F. V. Coville, Honorary Curator of the Department of Botany, furnishes the following brief account of the collection of plants:

"With reference to the collections in the Department of Botany, it may be said that they constitute what is commonly known as the National Herbarium. The nucleus of the herbarium consisted of the plants collected by the Wilkes Exploring Expedition during the years 1838 to 1842. To these were added later the material from the North Pacific Exploring Expedition of Ringgold and Rodgers, followed by those of Frémont, the Mexican Boundary Commission, the Pacific Railroad Surveys, and all the later explorations and expeditions of the government.

"In recent years the largest amount of material received has come from the Division of Botany in the Department of Agriculture, material brought together in the pursuit of the investigations of that establishment. Especially noteworthy among these is the collection of grasses which Doctor George Vasey gathered during his studies of the forage plants of the United States during a period of about twenty years.

"To the collections of the exploring expeditions and those of the Department of Agriculture has been added a large amount of material donated by American botanists or purchased from collectors, besides large consignments of plants received from various foreign institutions or individuals principally as gifts or in exchange.

"The collections of the exploring expeditions and the collection of grasses are especially rich in type-specimens.

"Mention should be made of the collections of George Joad, comprising about ten thousand species of representative plants of the globe, more especially those of Europe; and the collection of Professor Lester F. Ward, comprising the specimens on which his "Flora of Washington and Vicinity" is based, in addition to important collections made by Professor Ward and his correspondents in other parts of the United States. Both the Ward and the Joad collections were acquired by the museum in 1885."

The important collections of the Department of Minerals are summarized by Mr. Wirt Tassin, Assistant Curator, as follows:

"At the request of Professor F. W. Clarke, the Honorary Curator, I have prepared, and transmit herewith, a list of some of the most important collections and single objects in the Mineral Department. They are:

"The Isaac Lea collections, including a collection of minerals, a collection of micas and quartzes, and a collection of gems and ornamental stones, among which may be noted as of especial interest a fine green tourmaline of fifty-seven carats, a red specimen of eighteen carats and a hair-brown one of sixteen carats, from Mount Mica, Paris, Maine. A doubly terminated emerald crystal from Stony Point, Alexander County, North Carolina, one of the largest ever found, measuring three and one-tenth by two inches and weighing eight ounces and three pennyweights. A crystal ball cut from North Carolina quartz. A silver nugget weighing four hundred and forty-eight ounces, from near Globe, Arizona. One of the largest known cut Ceylon essonites. Four large Ceylon asteria. A fine suite of opals in argillaceous limonite, Baracoo river, Queensland.

"The Leidy collection of minerals, received from the United States Geological Survey.

"A series illustrating the occurrence and associations of

the zinc and lead minerals of Southwest Missouri, collected by W. P. Jenney.

"A series illustrating the mineralogy of the Pikes Peak region collected by Whitman Cross, of the United States Geological Survey.

"A series of original and type zeolites from Table Mountain, Gunnison County, Colorado, collected by Whitman Cross, of the United States Geological Survey.

"A series of uranium minerals used in the work leading to the discovery of nitrogen in uraninite and later of argon, given by Doctor W. F. Hillebrand.

"A series of copper carbonates from Copper Queen Mine, Arizona, a gift of the Copper Queen Consolidated Mining Company, through James Douglas, President.

"A series of azurite crystals and associated minerals from the copper regions of Arizona, together with a series of vanadium minerals from New Mexico, collected by Doctor W. F. Hillebrand.

"A series illustrating the occurrence and association of the zinc minerals of New Jersey, collected by Wirt Tassin.

"The type-specimens of warrenite.

"A slab of sodalite, size two by two inches; a polished slab of labradorite, two by two inches; a slab of calcite crystals four by four inches; two large sections of agatized wood from Arizona, deposited by the Drake Company; the 'Ontonagon' copper boulder; a series of Sicilian sulphur crystals; the Shepard collections of meteorites; the Ring or Irwin meteorite; a suite of meteoric irons from Cañon Diablo, Arizona, varying in weight from 964 pounds to a few ounces.

"To the list may be added the Stroud collection, the Hawes collection, the Abert collection, the various accessions received at different times from the United States Geological Survey, and other smaller collections containing valuable material of scientific and other importance."

Of the Department of Paleontology, Mr. Charles Schuchert, Assistant Curator, writes:

"The feature of greatest importance is that much of our material has served in government reports, and is the basis for the geological and paleontological work treating of the western part of our country. This fact is well exemplified in the great number of species which have served in description and illustration, many of which are the original type-specimens. There are of such species five thousand seven hundred and forty-one. These are distributed in the sections of this department as follows:

Paleozoic Invertebrate species	1155
Mesozoic " "	1024
Cenozoic Invertebrate species	1304
Vertebrate species	161
Paleozoic plant species (Lacoe collection)	504
Mesozoic and Cenozoic plant species	1531
Insect species	62

"The most complete series is the 'Lacoe collection of American Paleozoic plants,' the labeled specimens of which alone number upwards of eighteen thousand, and of these more than five hundred species have been described or illustrated by Lesquereux and White. This magnificent collection is the result of many years' accumulation, and cost upwards of $50,000. It was donated to this museum in 1891, by Mr. R. D. Lacoe, of Pittston, Pennsylvania.

"The collection of Cambrian fossils is very large, and when Mr. Walcott shall have completed his studies upon this material, it will be the most complete and valuable series of fossils of this system extant.

"The Cretaceous collection is also quite extensive and represents much work by F. B. Meek, C. A. White, and T. W. Stanton.

"The Tertiary collection of Mollusca is one of the conspicuous features of this department. This collection was accumulated chiefly by William H. Dall.

"Among single objects the following deserve mention:

"A composite slab of Lower Carboniferous fossils measuring four by six feet, and showing in high relief one hundred and six crinoids (sixteen species) and other fossils.

"A Lepidodendron trunk three feet wide and thirty feet long (Lacoe collection).

" A series of six cycad trunks from the Lower Cretaceous of South Dakota.

" Bones representing a nearly complete *Zeuglodon cetoides* from the Eocene of Alabama, and of which a life-sized restoration is exhibited.

" Skulls and limb bones of the huge Cretaceous Dinosaur, *Triceratops*, from Wyoming.

"An excellent skeleton of the Irish Elk, *Megaceros hibernicus*, Owen."

The collections of the Department of Prehistoric Anthropology are thus described by the Curator, Doctor Thomas Wilson:

"There are three great stages of culture, or civilization, represented in this Department, which are separated and installed according to locality.

"The first, and probably the earliest, is that of Western Europe, of which the museum possesses an extensive collection, the largest in the United States, showing the culture of prehistoric man, from the earliest times down to the Bronze Age and the Etruscans, where it joins history.

"The second great division represents the territory of the United States and British Columbia. This constitutes the bulk of the collection, and comprises the hatchets, axes, implements, and other objects of stone. The mounds of the Ohio and Mississippi valleys have yielded large representations of pottery.

"The third stage of culture is that belonging to Mexico and Central America, variously called Aztec and similar local names. While it comprises many stone implements, it extends further and wider than either of the foregoing, having jade, obsidian, and gold objects and ornaments. Its pottery is fine and beautifully made and decorated; while some of the ruder pieces, representing gods, especially from

Mexico, are made with a wealth of detail that has increased the difficulty of manufacture almost beyond the belief of possibility in savage life.

"The display from South America is important, resembling the culture of Central America more than that of North America.

"The Department has one of the richest displays of prehistoric objects in the United States. It contains more than two hundred and fifty thousand objects, which it is impossible to name. They, however, are divided both technologically and geographically, and by comparison in these two regards the endeavor is made to determine the stage of culture and obtain some insight into the history of prehistoric man."

Regarding the Department of Ethnology, the Curator, Professor Otis T. Mason, writes:

"The ethnological collection of the museum relates chiefly to the North American Indians, but it includes also valuable series of objects from Polynesia, obtained by the United States Exploring Expedition, such as the old Tapa cloths and weapons, which are no longer obtainable at present.

"The Eskimo collection is unrivaled. The collections of the Bureau of Ethnology and other government surveys on the west coast of the Pacific Ocean in North America, and in the Pueblo region of the southwestern United States, are the most extensive and valuable ever assembled. Among single objects of high value and rarity may be mentioned a large jade knife from Alaska, obtained by E. W. Nelson; a fine series of boats and totem posts from the west Pacific coast of America, by J. G. Swan. In the Powell collection there are rare old pieces of pottery from the ruined Pueblos. A Hawaiian feather cloak, of large size and well preserved, also deserves mention.

"I present the following list of the most conspicuous and useful collections in alphabetical order, by collectors:

"A collection of great value from Eastern Africa, Kashmir,

and southeastern Asia, by Doctor William L. Abbott, of Philadelphia; a collection illustrative of the ethnography of Korea, by Lieutenant J. B. Bernadou, U. S. N.; a collection from the Department of Education in Japan to illustrate the practical industries of this country, in comparison with the tools and appliances brought home by Commodore Perry; the collection of Doctor Franz Boas, illustrative of the ceremonial usages of British Columbia and the Northwest coast; of Captain John G. Bourke, U. S. A., gathered from Indian tribes in the United States during his long engagements on the frontier; of Doctor J. F. Bransford, U. S. N., pottery and other materials from the graves of Nicaragua; enormous collections from the great Interior Basin and Pueblo region to illustrate the costume and arts of the Shoshonean and Pueblo tribes, also materials gathered by James Mooney and others of the Bureau of Ethnology from the tribes in the Indian Territory; collection of Heli Chatelain, from Angola; large collection from the Chinese Imperial Commission of the Centennial Exhibition in Philadelphia; a rare old collection from Liberia and vicinity, made by the Colonization Society of Washington; collection illustrative of the games of the world, by Stewart Culin, of Philadelphia; collections especially from South America made by the government agents for the World's Columbian Exposition in Chicago; collections of William H. Dall, associated with Doctor Tarleton H. Bean and Marcus Baker, in various parts of Alaska; collections, well labeled, from the Tlingit Indians, by Lieutenant George T. Emmons, U. S. N.; a small but extremely valuable collection from west Greenland, by Governor Fenckner; a precious collection of pottery and other objects from old ruined pueblos in New Mexico and Arizona, by Doctor J. Walter Fewkes; collection of William J. Fisher from the Eskimo and Aleuts on the Alaskan Peninsula, the Island of Kadiak and vicinity; collection of William M. Gabb from Central America; old and precious collections from Oregon and British Columbia, by George Gibbs; a small and rare collection from the west coast of South America, by Lieutenant J. M. Gilliss, U. S. N.; a small and extremely rare

collection from Fury and Hecla Straits, by Captain Charles F. Hall; collections of the Geographical and Geological Survey of the Territories, by Doctor F. V. Hayden; small collection from North Greenland and Grinnell Land, by Doctor I. I. Hayes; collection from the Amazon River, by Lieutenant Herndon, U. S. N.; collection from the Ainos and northern Japanese, by Romyn Hitchcock; collections from the Indians of the western Great Lakes, by Doctor W. J. Hoffman; collections from the Swiss Lake dwellings, by Professor Joseph Jillson; collections from southeastern Japan, by P. L. Jouy; collections from the Mackenzie River district, by Mr. Robert Kennicott; royal gift from the King of Siam, through General J. A. Halderman; collection from Cumberland Gulf, by Ludwig Kumlien; a priceless collection of antiquities from Porto Rico, by George Latimer; collection from Bristol Bay, by Charles L. McKay; extremely valuable collection from Mackenzie River district, by Robert MacFarlane, of the Hudson Bay Company; collection from the Congo region, by Dorsey Mohun; collection from the Sioux tribes of Dakota, by Doctor Washington Matthews, U. S. A.; an immense collection, covering many thousand numbers, from Alaska, by E. W. Nelson; collections from the Southwest and Mexico, by Doctor Edward Palmer; collections from Japan, by Commodore Perry, U. S. N.; collections from the tribes of Utah, by Major J. W. Powell, of the United States Geological Survey; collections from northern and central California, by Stephen Powers; collections from Kotzebue Sound and of the Hupa Indians from northern California, by Captain P. H. Ray, U. S. A.; collection from Thibet, by the Honorable W. W. Rockhill; collection from the Chukchis country and Alaska, by Commodore John Rodgers, U. S. N.; collection from the Mackenzie River district, by B. R. Ross, of the Hudson Bay Company; collection from Peru, by Lieutenant W. E. Safford, U. S. N.; collection by Reverend George W. Samson, from the Holy Land; collection by Paul Shoemaker on the shell heaps of the West Coast, especially Santa Barbara Island; collection of Lieutenant G. M. Stoney, U. S. N., from Kotzebue Sound;

collection by James G. Swan, from the North Pacific Coast of America; collection by Talcott Williams, from North Africa; collection by Lieutenant E. H. Taunt, U. S. N., from the Congo region; collection of Doctor William M. Thomson, U. S. N., from Easter Island; collection of Honorable W. P. Tisdell, from the Congo region; collection of Lucien M. Turner, from Labrador and North Sound; collection of Captain G. M. Wheeler, U. S. A., from Southern California; collection of Captain A. W. Whipple, U. S. A., from Southwest; collection of Rouncevelle Wildman, from eastern China; collection of the Wilkes Exploring Expedition from Polynesia to the west coast of America.

"In addition to those already named should be mentioned the various branches of the United States executive service, the Department of State, the War Department, the Navy Department, and the Department of the Interior."

Of the Section of Oriental Antiquities and Religious Ceremonials, Dr. Cyrus Adler writes:

"This Section comprises a small collection, interesting, not so much because of the intrinsic value of the objects as because of the relation in which they are shown. It may be divided, according to religions and nations, into nine sections: 1, Biblico-Judaic; 2, Christian; 3, Mohammedan; 4, Egyptian; 5, Assyro-Babylonian; 6, Hittite; 7, Græco-Roman; 8, Brahman; 9, Buddhist.

"Of the Biblico-Judaic section, the collection of manuscripts and editions of the Bible and its versions (forty-one in number) may be considered as the most important, having both a literary and paleographic interest. Next to this may be mentioned the collection of objects of Jewish ceremonials, which, besides being a complete set of the objects used by the Jews in their religious observances, is of much artistic and historical value.

"In the Egyptian section the mummy with its cases and the facsimile of the 'Book of the Dead' rank foremost. In the Assyro-Babylonian section the most imposing objects are the

two colossal composite figures and the model of a temple tower of Babel, the latter being unique. For purposes of the study of the mythology and culture of Mesopotamia the collection of seals (upwards of three hundred in number) is important.

"The whole collection of Hittite casts (thirty-eight) is unique in America, and affords a basis for the study of the history and civilization of this people who played such an important part in the ancient history of the Orient.

"In the Græco-Roman division rank foremost the Serpent Column of Delphi and the reliefs of the pedestal of the Obelisk, both from the Hippodrome in Constantinople. These casts are unique.

"In the Buddhist section there are some fine images of Buddha of carved wood and bronze, models of pagodas from Japan, and a rare collection of musical instruments as well as other religious implements from China.

"A rare piece of Mosaic representing a lion attacking a horse, from an ancient temple in Carthage, also deserves especial mention."

The varied collections grouped together in the department of "Arts and Industries" are not readily summarized, but the following statements of those having the most important series in charge will be of interest:

"In the Section of Historical Collections," writes Mr. A. Howard Clark, Honorary Curator, "are exhibited personal relics of representative men and memorials of events and places of historic importance. The nucleus of the collection was the Washington relics transferred from the Patent Office in 1883, and these still comprise the choicest of the historical treasures, including, as they do, so many objects intimately associated with General Washington during his home life as well as military campaigns. Furniture, porcelain, glassware, and ornamental articles from Mount Vernon, Royal Worcester vases presented to him by Samuel

Vaughan, the Martha Washington china, presented by Van Braam, a beautiful Niederweiler bowl, personally presented in 1792 by the Comte de Custine, and a nearly complete dinner service of Chinese-ware decorated with the insignia of the Society of the Cincinnati; and besides these, the tents, camp chest, field-glass, and writing-case used by Washington during the War of the Revolution, as also miniature portraits of the General and Martha Washington painted on wood by the artist Trumbull.

"Next in importance to the Washington relics are the almost priceless memorials of General Grant: the saddle, sword, field-glasses, and other objects used by him during his military career, all his commissions in the army from Lieutenant by brevet during the Mexican War up through the several grades to General, and his certificate as President of the United States; handsomely mounted swords; and the great gold medal with which he was honored by Congress for his military services; many elegant gifts received during his tour of the world, including the beautiful jade vase and ornamented bell standard given him by Prince Kung of China.

"By the side of these treasures are valuable gifts to Presidents of the United States and to statesmen, soldiers, and other representative Americans; some Moorish guns highly decorated with gold and coral, and a gold-mounted sword, gifts to Thomas Jefferson from the Emperor of Morocco; jeweled and gold-scabbard swords presented by citizens of States and cities for military bravery to General Ripley, Commodores Elliott and Biddle, Admiral Trenchard, Generals Hancock, Paul, and others.

"Here, too, are exhibited the great gold medal presented by Congress to Joseph Francis for his service to the world as inventor of life-saving appliances; the beautiful vase presented to Professor Baird by the Emperor of Germany as the grand prize of the Berlin International Fishery Exhibition; the silver urn from the citizens of Baltimore to Commodore John Rodgers for his services in defense of that city during the War of 1812; the garrison flag of Fort Moultrie

in December, 1860, when that fort was evacuated by Anderson; the war saddle of Baron de Kalb, who gave his life for American independence; the uniform worn by General Jackson at the battle of New Orleans, and many other individual objects of great historic value.

"A most instructive historic treasure is the Copp collection of household objects and wearing apparel, illustrating the home-life of the New England colonists from 1635 to the period of the War of the Revolution, the gift of Mr. John Brenton Copp.

"As a precious treasure in memory of the immortal Lincoln, there is the original plaster life-mask. Equally interesting are the molds of the hands made by the sculptor Volk, in 1860, just prior to the nomination of Lincoln for President of the United States.

"As a most conspicuous object, and a treasure as well, may be mentioned the original full-size plaster model of 'Liberty' by Crawford, from which was cast the bronze statue surmounting the United States Capitol."

Of the Sections of Transportation, Engineering, and Naval Architecture and Physical Apparatus, Mr. J. E. Watkins, Curator, writes as follows:

"The collections in transportation, engineering, and naval architecture, although not great in extent, are particularly valuable on account of the historical interest of almost every object which has been collected and is now on exhibition. Notable among the objects is the cylinder of the first steam-engine erected on the Western Continent, by Josiah Hornblower, in 1753, sixteen years before James Watt began his investigations of the properties of steam. The museum has also been fortunate in obtaining the original machinery of the Stevens twin-screw propeller steam-boat, constructed and operated in the year 1804, three years before Robert Fulton operated the 'Clermont' on the Hudson River. The original multitubular boiler of the Stevens locomotive of 1825, which ran in Hoboken, New Jersey, four years before Stephenson's

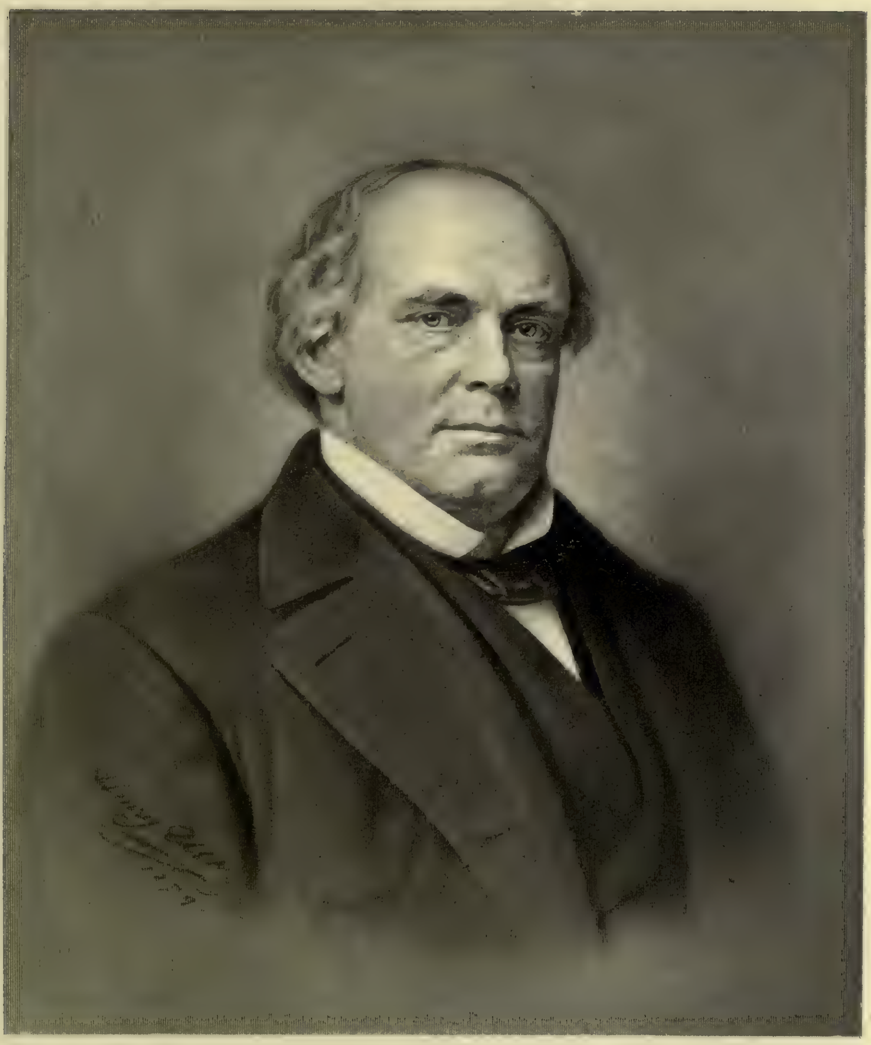
'Rocket,' also forms a part of this collection. A cylinder and other portions of the locomotive 'Stourbridge Lion,' the first locomotive built for traffic on the Western Continent, was obtained several years ago through the coöperation of Horatio Allen, who, in August, 1829, first ran this locomotive near Honesdale, Pennsylvania. The series showing the development of permanent way in America is unique, as are the two collections of models showing the development of wheel vehicles and machinery of the steamboats invented by Rumsey, Fitch, Fulton, and Ericsson.

"The Ramsden dividing engine, used in the last century to divide equally the circles of quadrants and other mathematical instruments, which is the earliest machine of this kind extant, also forms a part of the collection of apparatus. A very important and valuable recent addition to this section is the seismological apparatus displayed at the World's Columbian Exposition in the Japanese exhibit, and since presented to the museum by that government.

"The electrical collections contain objects of extreme importance and value. Among these may be mentioned one of the first three large horseshoe electric magnets, wound and experimented with by Henry, together with the battery, first motor, and other similar appliances constructed by Henry while in Princeton; and the original telegraph apparatus invented by Professor Morse. The original telegraph instrument from which was received the historic message, 'What hath God wrought,' in Baltimore, 1844, also forms part of this collection, together with objects illustrating the beginnings and development of the storage battery and electric incandescent and arc lamps, and other electrical apparatus.

"The telephone which Johann Philipp Reis, of Frankfort, invented in 1860, is another object of much interest and value."

The collection of Materia Medica is probably the most complete and most carefully labeled collection of its kind exhibited in any museum. It is very full in many directions,



and is especially rich in specimens of cinchona. Of the latter series Doctor J. M. Flint, U. S. N., the Honorary Curator, writes:

"I regard the collection of cinchona products as the most important in the Materia Medica Section. This collection embraces specimens of nearly all the natural cinchona barks of South America, every variety of the cultivated product from the government plantations in India, together with most of the cultivated sorts from Java, Ceylon, Jamaica, and Mexico. The India and Jamaica collections comprise also herbarium specimens of the leaf and flower, and in many cases the fruit of each variety of cinchona tree from which the bark is taken."

Of the Section of Graphic Arts, Mr. S. R. Koehler writes:

"This Section was definitely organized in January, 1887, although its beginning goes back to at least the year 1884. From a very few specimens then on hand the collectors in this section have increased to the number of five thousand six hundred and twenty specimens at the present writing, but as many of the entries on the catalogue cover more than one specimen, it will be safe to say that the total number is about six thousand.

"The aim of the Section is to illustrate the various processes of making pictures by lines and masses, either black or in colors, by hand, or with the aid of machinery, and the application of these processes in the industrial arts. To reach this aim, all the methods of making pictures that have ever been essayed are eventually to be illustrated,—and many of them are already illustrated,—by the tools and materials used, by the product in the various stages of progress, and by historical examples showing the development of each process, from the invention to the present time."

In addition to the collections already noticed, the museum possesses a good series of musical instruments, assembled

under the immediate direction of Doctor Goode; a collection of porcelains, bronzes, and ivory carvings; a large and varied collection illustrating fisheries, which was brought together chiefly in connection with the Fisheries Exhibition of Berlin and London; a small forestry collection; a collection of foods; a collection representing the utilization of industrial products derived from animals; a collection of fibers and textiles; and a series of objects illustrating the chemical composition of the human body.

I have already alluded to the work done by the Museum in the direction of supplying from its surplus the needs of other scientific and educational establishments.

This undertaking was inaugurated at an early date, as I have stated on a preceding page (page 323), and already in 1866, at the end of the second decade of the Institution, 110,000 specimens from the collections had been distributed. At the close of the fifth decade, in 1896, the number had risen to 521,000 specimens. These included animals of every class and many geological and mineralogical specimens and plants.

Every State and Territory in the Union has received a share of these collections, and numerous institutions outside the United States have also been beneficiaries in the distribution.

The majority of these specimens were distributed without demand for, or expectation of, a return; but the National Museum has received from other institutions in exchange for the collections sent out a body of specimens amounting in all to perhaps one-third the number distributed. Important additions have been made to the Museum in this way, and, indeed, its surplus collections, owing to the comparatively small amounts available for purchases, have constituted its chief capital. The system of exchanges, however, has its

limitations, which are soon felt. Few institutions carry large quantities of surplus material, and none, of course, dispose of their most precious possessions. Exchange, therefore, takes the place of purchase only to a limited extent.

The Smithsonian Institution has carried on the distribution of surplus specimens from its own collections as a part of its regular activities, having for their object the diffusion of knowledge. The government has shown its acquiescence in this policy, so far as the national collections are concerned, by several enactments making appropriations for the work, and in other ways.

In 1878 the Museum began the publication of a scientific journal, which has become well known to the world of science under the name of "Proceedings of the United States National Museum." The object of this journal, as indicated in the "advertisement" inserted in the volumes, is "the prompt publication of freshly acquired facts relating to biology, anthropology, and geology; descriptions of restricted groups of animals and plants; the settlement of particular questions relative to the synonymy of species, and the diaries of minor expeditions." Eighteen volumes had been published to the close of 1895, containing in all no fewer than 1100 papers, comprising 12,056 printed pages. All the papers relate directly or indirectly to the collections of the Museum and serve to make them known to specialists. The volumes include[1] a large share of the scientific publications of the curators of the Museum, whose investigations have very naturally been based for the most part on the collections under their care. The "Proceedings" is a great storehouse of facts relating to natural history, and especially in

[1] With the "Bulletins" to be mentioned presently.

the field of systematic zoölogy, but the work of every department of the Museum is reflected in its pages.

A few years before the establishment of the "Proceedings," in 1875, the Museum began the publication of a series of monographic works, under the general title of the "Bulletin of the United States National Museum," which in 1895 had reached 49 numbers. This series does not differ essentially in character from the "Proceedings," but comprises for the most part works too large to be conveniently included in the latter journal, and generally of a more comprehensive scope.

The regular series of both "Proceedings" and "Bulletin" are in octavo, but the Museum has also published three numbers of the latter series as "Special Bulletins" in quarto. Two of these contain "Life Histories of North American Birds, with special reference to their breeding habits and eggs," by Major Bendire, and the third a treatise on "Oceanic Ichthyology," by Doctor Goode and Doctor Tarleton H. Bean.

The Report of the Board of Regents of the Smithsonian Institution until 1884 consisted each year of a single volume in which was included a statement of the operations of the National Museum. The Report of 1884, however, and those of subsequent years have been published in two volumes, of which one is devoted exclusively to a statement of the work of the Museum. In connection with the administrative reports contained in these volumes have been published a series of illustrated papers of a non-technical character descriptive of various collections in the Museum. These papers have the same interest for non-professional readers that the technical papers in the "Proceedings" have for investigators, and the demand for them reveals a widespread interest in zoölogy, botany, anthropology, and those other subjects with which the work of the Museum has been most closely connected.

BUREAU OF AMERICAN ETHNOLOGY

By W J McGee

THE germ of the ethnological bureau was an exploration of the cañons of the Colorado fostered by Joseph Henry, organizer of the Smithsonian Institution. Begun in amateur fashion among the Rocky Mountains during the summer of 1867, by Major John W. Powell and a few associates, the exploration was gradually pushed down the tributaries to Grand River, then to the Green, and later to the mud-tinted Colorado; and in 1869 the rugged gorge of Green River and the fitly named "Grand" cañon of the Colorado were traversed by Powell and his intrepid companions. This exploration was the boldest in design and the most perilous in execution among the scientific expeditions recorded in the annals of the nation.

Before, during, and after the passage of the cañons, observations were extended over the country drained by the rivers, and gradually the exploration became a survey, first geographical, then geological, and finally anthropological. At first the plan was simple and the work was prosecuted at the cost of the surveyors; as the difficulties increased the plan was elaborated that they might be overcome, and a

number of persons who had become interested in the work contributed toward the means required for carrying it on; finally, in 1871, the Congress made an appropriation, to be expended under the direction of the Smithsonian Institution, for continuing the explorations and surveys. Both before and after this enactment, Professor Henry warmly encouraged the work and guided it by wise counsel. His aid is commemorated, and will be so long as our language lives, in a noble monument — the Henry mountains.

When the survey was organized under Congressional provision it was designated "The United States Geographical and Geological Survey of the Rocky Mountain Region." The work was placed in Major Powell's charge. In pursuing the researches, much attention was given to the aboriginal inhabitants, and extensive collections representing their arts, languages, institutions, and beliefs were made, and the objects collected were preserved in the Smithsonian Institution. On July 1, 1874, the survey was transferred to the Department of the Interior, while its plan was extended, though not materially modified save that the anthropological researches were made more prominent; and in 1876 a series of reports on the Indians, entitled "Contributions to North American Ethnology," was projected, with the concurrence of the Secretary of the Smithsonian Institution, and during the ensuing year two volumes of the series were published. At this stage the work seemed to be definitely established under federal auspices, and, in accordance with a wise and liberal custom, the head of the Smithsonian Institution withdrew from active investigation of the Indians and freely transferred to the survey the rich collection of linguistic manuscripts accumulated during the preceding thirty years.

At the opening of 1879 there were four organizations engaged in surveys and researches in the Western Territories,

including the "Geographical and Geological Survey of the Rocky Mountain Region;" by an act of Congress approved in March of that year the work was reorganized, and the four bureaus were united in the United States Geological Survey, while provision was made for continuing the anthropological researches under the direction of the Smithsonian Institution; and Professor Spencer F. Baird, then Secretary of the Institution, confided the direction of the work to Major Powell. This was the beginning of the Bureau of American Ethnology.

Appropriations for continuing the researches concerning the American Indians at the cost of the federal government and under the direction of the Smithsonian Institution have since been made annually by Congressional action. The new bureau at once began and has since continued the publication of annual reports, and also carried on the "Contributions to North American Ethnology" until the series was brought to an end by the printing law of 1895; in addition a series of bulletins and certain special publications have been issued.

On April 1, 1880, Major Powell was made Director of the United States Geological Survey, but continued in charge of the bureau of ethnology, and devoted a part of his energies to researches concerning the Indians. In 1893 his health was precarious, and on July 1 of that year the writer was appointed Ethnologist in Charge. A year later Major Powell resigned the control of the Geological Survey, but retained that of the bureau, and has since devoted himself wholly to the completion of the researches begun on the headwaters of Rio Colorado in 1867.

In the original exploration, in the official survey of the Rocky Mountain region, and later in the present bureau, Powell pursued a liberal policy, with great enthusiasm, under

which expert collaborators were enlisted, and the aid of men of genius was sought; and he, more than all others, realizes that whatever of value may be found in the results of the work is to be credited in great part to devoted collaborators, some of whom gained international repute through researches in the bureau. A few of the workers, like the Mindeleff brothers, Jeremiah Curtin, and Doctor Walter J. Hoffman, have turned into other paths, while Professor William H. Holmes has gone to a position of honor for which his bureau training was a preparation. Doctor Albert S. Gatschet and Professor Cyrus Thomas have grown old in constant duty, but retain their vigor and wealth of experience; Frederick Webb Hodge and J. N. B. Hewitt, James Mooney, and Mrs. Matilda Coxe Stevenson have grown up with the bureau, and Frank Hamilton Cushing has spent half his career in its service; while Doctor J. Walter Fewkes has recently been added to the corps. Henry W. Henshaw broke in his prime, and his complete restoration is still in the future; Stevenson, Reynolds, Mallery, Dorsey, and Pilling fell in harness, and live only in their works — their names are enrolled in the fane of science.

When the bureau was instituted, the experience and the tangible results of the preceding years of research were utilized by Director Powell in shaping its plan. It was recognized that anthropology is a young and imperfectly organized science; it was also recognized that the subject matter of anthropology is more complex than that of any other science. Accordingly it was deemed important to design and conduct the researches in such manner as both to organize and diffuse anthropological knowledge. Moreover, the American natives were regarded as offering a field for research more extensive, more clearly defined, more completely virgin, and more easily

wrought than any other within reach of students working under governmental auspices; and from the beginning it was the aim to cultivate appreciatively this vast and fertile field, and to join the anthropologists of the world in harvesting improved and extended knowledge. Such was the primary plan of the Bureau of American Ethnology — to found as well as to extend the science of man.

When the researches began, certain general methods were adopted. In accordance with the best scientific usage, research began with actual observation on the ground; recognizing the complexity and elusiveness of human phenomena and the fallibility of human perception, observations were repeated and usually verified by others before acceptance; nothing was taken for granted, and even the most widely accepted theories were held in abeyance until tested by trained observers. As observations multiplied, they were compared in order that relations might be discovered, and ultimately the facts were grouped by relation. In this work the several collaborators coöperated with the original student, in order that the chance of erroneous grouping might be reduced. When the detailed observations were of widespread interest, they were published in part or in full; when they were of technical character, or for other reasons of interest to few persons only (as in linguistics), only typical collections were published, the mass being held for comparative study. As research progressed the relations themselves were compared and grouped, for the purpose of educing laws of relation, or principles. This work was performed largely by Director Powell, who not only originated, but constantly coordinated the various lines of research; though collaborators were always encouraged to seek relations and educe principles, and to publish under their own names such results of their work as were not inconsistent with those of other in-

vestigators; for it was recognized that research is best promoted by encouraging the investigator. Such have been the general methods in the bureau; they are in no way peculiar, and are worthy of statement only as the basis on which the researches of the bureau have always rested.

As the researches progressed the plan matured in special methods growing out of special conditions. It was found that the native Americans are grouped in tribes bearing distinct names, possessing more or less distinctive attributes, and occupying more or less definite areas, so that in current thought and in history the tribe had come to be regarded as a primary ethnic unit; and the work became accordingly an investigation of American tribes. The questions asked by anthropologists concerning the native tribes commonly run in a certain order. The first demand is for definition or more extended description; the second is for the geographic position or distribution of the tribe; while the third is frequently connected with the social and other relations of the tribesmen; somewhat less frequently questions arise concerning the history and prospects of individual tribes, and ethical questions of such character as to fall within the legitimate domain of official inquiry occasionally arise. To all such intelligent and definite demands for information it seemed desirable to make answer, and thereby the special methods of the bureau were shaped; and, so far as conditions permitted, the tribes have been classified, their distribution has been determined, their organization and institutions have been ascertained, and their history has been deciphered and recorded. Yet it was recognized throughout that each tribe is but a minute part of a great assemblage — the American people; and it has ever been sought to so shape the researches as to contribute toward answering all legitimate inquiries concerning the relations of this important branch of

mankind among each other as individuals and tribes, as well as to the other peoples of the world.

The operations have varied from time to time with conditions, including official requirements, administrative necessities, and the demands of growing science. The most potent of these conditions in shaping the operations of the bureau was an official demand to which the institution of the bureau was a partial response. Statesmen and administrative officers concerned with placing the Indians on reservations felt the need of a practical classification of the Indian tribes under which they might be arranged in amicable groups; this need was urged on Major Powell while Director of the Rocky Mountain Survey, and the anthropological researches of the survey were bent to meet it; and when provision was made for continuing the work it was understood that the primary duty of the new bureau should be the classification of the Indian tribes for practical as well as for scientific purposes. One of the effects of this requirement was to give a name to the office, which thus came to be designated a bureau of ethnology; another effect was to confine the early operations of the bureau to the United States, though it was planned by statesmen to extend operations over North America at the outset and finally over the hemisphere, and the terms of the law were fixed in accordance with this purpose. The most profound and far-reaching effect of the plan was the rapid development and early application of a mode of classification, which has guided the subsequent operations of the bureau. In the infancy of anthropology the races of men were classed by color of skin, character of hair, form of cranium, attitude of eyes, and other corporeal or physical features; even before the creation of the bureau certain anthropologists, notably Gallatin in the second quarter of the century, realized that, while the American aborigines may

perhaps be discriminated collectively on the physical basis, the tribes, the confederacies into which they are sometimes united, and the clans and gentes of which they are composed, are defined by purely human attributes growing out of the preëminently intellectual character of mankind. The studies of the Rocky Mountain Survey had shown that the human attributes are essentially collective, at once the product and parent of coöperation among individuals; and hence that the classific unit among mankind is not the individual, as among lower animals, but the coöperative group. When the force of the official demand for a practical classification of the Indians was felt, and it was recognized that a physical classification was incompetent, the collective or demotic characters were carefully considered; and it was soon perceived that the tribes of identical belief are commonly harmonious, and might safely be grouped on reservations; it was also found that similarity in institutions usually accompanies similarity in belief and conduces to harmonious relation; and it was found too that similarity in arts prepares the way for pacific association. Further study showed that tribes having related arts commonly spoke related tongues, that tribes of related institutions almost invariably spoke cognate dialects, and that similarity in belief was always accompanied by close similarity or identity in speech. Thus it was ascertained that the tribes might be classified roughly by arts, more definitely by institutions, and with sufficient refinement for all practical purposes by beliefs; and at the same time that language is equally useful with belief as a basis for classification, while its data are more easily obtained. Accordingly the linguistic classification was adopted; and through the aid of collaborators and correspondents material pertaining to the native languages was rapidly collected.

Through administrative necessities each collaborator has

been compelled to distribute his energies among different tribes, often among different stocks; for it has never been deemed wise by statesmen interested in the work to maintain a force sufficiently large to permit the assignment of a collaborator to each tribe, confederacy, or stock. In consequence the collaborators became specialists in departments of research concerning matters common to many or all tribes, some in linguistics, others in arts, still others in institutions and beliefs. It was soon noted that this differentiation in labor on the part of the anthropologists reflected a differentiation in activity among the aborigines; and it was found convenient to recognize formally this original differentiation and classify the work of the bureau thereby. Foremost among these, not only as the basis of all the others but in immediate importance, is language, including speech and the germ of writing; second in order of development and importance come the arts, esthetic and industrial; next in order are institutions; and perhaps youngest in origin and most interesting to thoughtful investigators are beliefs. These categories of activities are characteristic of all mankind, and have been called the humanities by Major Powell and some other students; they correspond with the chief lines of research in the bureau of ethnology.

At the outset it was the intention to devote energy largely or exclusively to researches among living tribes and tribal remnants in order that rapidly passing facts might be seized, and little attention was given to the more permanent relics of prehistoric art.* In 1881 the Congress was petitioned to so enlarge the scope of the bureau as to include a study of the archæology of the United States; and without the knowledge of the Secretary of the Institution, or the Director of the Bureau, an item making the requisite provision was added to the law. Under this specific official requirement,

researches concerning the prehistoric works of the country were undertaken.

Much effort has been devoted to investigation of the relations of the Indians among each other and to different peoples, partly with the view of facilitating collateral researches. Various methods and criteria of classification have been tested in the different departments of ethnology, and new methods and new criteria have been devised. These comparisons and studies have resulted in the adoption of a general classific method in which the phenomena are grouped first by origin or genetic relation, and second by conditions of development. Always at the beginning and sometimes at the end of an investigation important relations are unknown, when it is necessary to adopt arbitrary classific systems based on any convenient criteria; but it is the aim to replace the arbitrary systems by natural arrangements whenever the state of knowledge permits. On this basis the object-matter (the Indians) and the subject-matter (the knowledge) of the bureau's researches are classified.

The first demand for a practical classification of the Indian tribes was met by grouping the Indians north of Mexico and a part of those occupying the territory of that republic in fifty-nine linguistic stocks (or families), each usually comprising a number of tribes. These stocks, with the approximate number of tribes in each, are shown in the accompanying table. This classification of the American Indians was originally published in the seventh annual report of the bureau, and has been generally adopted in encyclopedias, textbooks, and other standard works relating to the American aborigines in this and other countries.

INDIAN STOCKS OF NORTH AMERICA, NORTH OF CENTRAL MEXICO.

Algonquian	36	Natchesan	2
Athapascan	53	Palaihnihan	8
Attacapan	2	Piman	7
Beothukan	1	Pujunan	26
Caddoan	9	Quoratean	3
Chimakuan	2	Salinan	2
Chimarikan	2	Salishan	64
Chimmesyan	8	Sastean	1
Chinookan	11	Serian	3
Chitimachan	1	Shahaptian	7
Chumashan	6	Shoshonean	12
Coahuiltecan	22	Siouan	68
Copehan	22	Skittagetan	17
Costanoan	5	Takilman	1
Eskimauan	70	Tanoan	14
Esselenian	1	Timuquanan	60
Iroquoian	13	Tonikan	3
Kalapooian	8	Tonkawan	1
Karankawan	1	Uchean	1
Keresan	17	Waiilatpuan	2
Kiowan	1	Wakashan	37
Kitunahan	4	Washoan	1
Koluschan	12	Weitspekan	6
Kulanapan	30	Wishoskan	3
Kusan	4	Yakonan	4
Lutuamian	4	Yanan	1
Mariposan	24	Yukian	5
Moquelumnan	35	Yuman	9
Muskhogean	9	Zuñian	1
Nahuatlan	?		

While this classification of the tribes is immediately and ostensibly based on linguistic characters, it has a much deeper significance than might appear at first glance. In the first place, the linguistic characters have been found to be interrelated with other characters, including those expressed in arts, industries, institutions, and beliefs, and were used in the classification only because, of the essentially collective or demotic features of the Indians, they were most easily ascertained. In the second place, the several cate-

gories of characters represented by language have been found, through study of traditions and direct survivals, to express the actual phylogenic development of the tribes and stocks. Accordingly each linguistic character is treated not merely as an external adventive feature, but as a product of evolution, a record of the past, and a precursor of the future. The classification of American Indians devised and applied by the bureau is accordingly a condensed expression of the sum of present knowledge concerning the origin and development of the native American people.

It has been ascertained that certain words in American languages are related in meaning to words of similar sound in transoceanic tongues; that the arrow of America is like that of the Orient and other parts of the world, not only in general form and function, but even in symbolic markings; that certain hieroglyphics of the Occident are similar to those of Egypt and the East in form and significance; that the calendar of Mexico duplicates in essential features the calendars of India and Arabia; that some social customs of America resemble those of Africa and Australia; and that the beliefs and ceremonials of the American aborigines simulate and sometimes exactly repeat those of India, China, and other countries. These parallelisms in the intellectual products of mankind have carefully been considered and weighed in the effort to trace general ethnic relation, and it has been found that in the vast majority of cases they cannot be regarded as indicating connection among peoples, and seem rather to indicate a law of mental action — the law that different minds of equal capacity respond similarly to like stimuli. This conclusion is expressed in different publications, notably a chapter by Powell entitled "On Activital Similarities" in the third annual report, and appears to be generally accepted among American anthropologists.

The linguistic researches and the classification of the native tribes by the bureau may be considered the continuation of the admirable work of Gallatin, who in 1836 published a "Synopsis of the Indian Tribes . . . in North America,"[1] in which eighty-one tribes belonging to twenty-eight families were enumerated. Even more closely were the researches connected with the plan communicated to the Smithsonian Institution in 1851 by Professor William W. Turner; for it was in accordance with this plan that the earlier linguistic collections were made under the auspices of the Institution, while these collections formed the nucleus of the material conveyed to the Rocky Mountain Survey and inherited by the bureau. Time has shown the wisdom of Professor Turner's plan, a part of which is worthy of repetition:

"Let the writer . . . describe the particular language under consideration; let all fanciful comparisons with Hebrew, Greek, etc., be excluded. Each grammar should note the dialectical peculiarities of the language of which it treats, and also the changes that may be taking place in it—that is to say, such as have been observed by the whites since they have been familiar with it, and especially such as are indicated by differences in the speech of old and young persons. To each grammar should be appended one or more specimens of composition in the language, with an interlinear English translation. For the purpose of comparison, the parable of the Prodigal Son is superior on many accounts to the Lord's Prayer, although it would be well to give both. But it is very desirable that to these should be added some original production of the native mind, — some speech, fable, legend, or song,—that it may afford samples of aboriginal modes of thought as well as of expression. It seems strange that so apparently obvious and easy a means of obtaining an insight into the workings of the mind of rude nations, which

[1] "Archæologia Americana," *Transactions and Collections of the American Antiquarian Society*, Worcester, 1836, Volume II, pages 1–422.

would prove of the highest interest to the philosophical inquirer, should have been hitherto almost entirely overlooked."[1]

So far as native speech is concerned, the methods and purposes thus set forth have been pursued, and the linguistic material has been collected not only for linguistic purposes, but as a means for the interpretation of the primitive mind; indeed the plan has been modified only by extending it to sign-language, pictography, hieroglyphics, decoration, painting, and tattooing.

The material in possession of the bureau representing the speech of the American aborigines is vast. During the seventeen years of its existence a considerable part of its energies has been devoted to the collection of such material; five quarto volumes of "Contributions" and two octavo volumes of "Bulletins" relating exclusively to Indian vocabularies, grammars, and texts have been published, besides nine volumes of a "Bibliography of the Indian Languages," and various special papers and chapters have been devoted to the same subject; yet the greater part of the linguistic collections remain unpublished, though in constant use. The catalogue of linguistic manuscripts, some of which are extensive, reaches 1533 titles, including 332 transferred by the Smithsonian Institution in 1876. The greater part of the material used in classifying the fifty-nine stocks and over eight hundred tribes above enumerated was collected by collaborators of the bureau. No other linguistic collection of comparable extent and variety is known to exist; and since the material was recorded in large part by trained linguists, and since all the languages and stocks represent a widely distributed people in the simpler stages of intellectual develop-

[1] "Smithsonian Report," 1852, Appendix, page 100.

ment, the bureau collection is invaluable to students of the origin and growth of language. The special treatises by J. Owen Dorsey, Doctor Gatschet, and other collaborators are well known to the students of all countries; the more comprehensive results are set forth in preliminary form only in Powell's "Introduction to the Study of Indian Languages" and in the earlier reports; yet these studies indicate many of the laws and conditions of linguistic development from early savagery well into barbarism.

The subject of sign-language was taken up soon after the institution of the bureau, and was vigorously pursued for some years, especially by Colonel Garrick Mallery. It was ascertained that this is a veritable art of expression, logically coördinate with lingual utterance, and perhaps of equal importance in the formative stage of language. The signs were originally demonstrative or mimetic, though many of them were developed into partially denotive symbols. By the use of these symbols the Indians were able not only to exchange intelligence at distances, but also to communicate with each other despite differences in dialects, and indeed, since the signs were less completely differentiated than the phonetic symbols, even when the speakers belonged to distinct stocks.

As the Indian spanned space by signals, so also he sought to bridge time by means of symbols painted or carved or embossed on the faces of cliffs or other suitable surfaces; and thus, long before the advent of white men, the aborigines entered the stage of graphic expression. This subject also was studied by Director Powell, Colonel Mallery, Doctor Hoffman, and others. Some indications were found that pictographic and decorative art sprang from the same ill-defined stem, but early became differentiated; and many indications were found that, while originally demonstrative and mimetic, the rude symbols of pictography soon began to

acquire a denotive meaning, and some of them became almost arbitrary. Colonel Mallery's memoir on this subject, forming the body of the tenth annual report, has been favorably received in this and other countries. The researches in pictography illustrate the mode of origin of graphic art, both linguistic and decorative; and the laws and stages of development exemplified by both signals and pictographs are in harmony with those illustrated in the development of speech.

The development of decorative art, which has been investigated by Professor Holmes and others, has been found measurably coincident with that of pictography on the one hand and that of hieroglyphics on the other, though the designs, always more or less definitely symbolic at the outset, were modified to fit the conditions residing in the medium or surface by which they were displayed. For this reason symbols carved on arrow-shafts became elongated, and symbols represented by patterns in woven fabrics became angular, while one of the consequences of the use of symbols in decoration was the development of arbitrary forms and the strengthening of the denotive tendency. Of the score of reports relating to this subject, that prepared by Professor Holmes in 1885 is, perhaps, the most noteworthy.[1] The influence of decorative art on the development of writing cannot be neglected, and the results of the researches concerning decoration are in accord with those flowing from the study of phonetic symbolism.

In certain groups, notably the Nahuatlan and Mayan, pictography was so well advanced at the time of the discovery that the symbols were conventionalized, sometimes into ideograms and phonograms, though some retained the original

[1] "A Study of the Textile Art in its Relation to the Development of Form and Ornament," in Sixth Annual Report of the Bureau of Ethnology, 1888, pages 189–252.

pictorial character, so that an inchoate hieroglyphic system existed among the Indians. As the investigation of speech, sign-language, and pictography progressed, it was found desirable to extend observation to the more highly developed native autographic records in the form of codices and carvings and paintings. The studies were conducted chiefly by Doctor Thomas; and several memoirs, relating in large part to the native calendar system, have been published. In three of these a system of interpreting hieroglyphics was set forth and applied;[1] another showed conclusively, for the first time, that the Maya year includes a bissextile;[2] while a memoir now in press elucidates the calendar more fully, and indicates the derivation and significance of the day symbols. The American hieroglyphics are especially important as marking the beginning of a definite art of graphic expression, thus throwing light on the critical stage in the development of writing. The laws of linguistic development discovered in the hieroglyphics are in accord with those educed from the study of speech, sign-language, pictography, and decoration.

The researches concerning the development of speech and the beginning of graphic art have served to define an important transitional stage in the growth of culture. Among enlightened peoples thought is crystallized and perpetuated by means of arbitrary characters which are combined in words, sentences, sums, and formulas, in such manner as to express ideas clearly and simply; while among primitive peoples thought is crystallized and perpetuated largely by means of arbitrary and often incongruous associations. The researches have shown that the prescriptorial mode of

[1] "Notes on Certain Maya and Mexican Manuscripts," in Third Annual Report of the Bureau of Ethnology, 1884, pages 3-65; "Aids to the Study of the Maya Codices," in Sixth Annual Report of the Bureau of Ethnology, 1888, pages 253-371; "A Study of the Manuscript Troano," in Contributions to North American Ethnology, Volume v, part 3, 1882.

[2] Thomas, Cyrus. "The Maya Year," in Bulletin No. 18 of the Bureau of Ethnology issued in 1894.

thought[1] is essentially distinct from that characteristic of the stage of writing; that few civilized men have learned to grasp primitive thought; and that no primitive man grasps civilized thought save at the end of a civilizing process. Indeed it would appear that it is this diversity in mode of thought rather than differences in arts, industries, institutions, and beliefs, more indeed than all other things combined, that separates primitive man from civilized.

Practically all the American tribes were in the domiciliary stage when the continent was discovered; and, while most of them occupied temporary or portable habitations, some resided in permanent villages, sometimes dominated by temples, council-houses, and barbaric palaces. The various types of structure have been investigated; the Iroquois long-house and the Siouan camp circle—products and exponents of social law—have been studied in detail; Casa Grande, the stateliest and best preserved prehistoric house in the United States, has been described and illustrated,[2] and means have been adopted for its preservation; the skin lodges of the plains, the bark-thatched wigwams of the eastern forests, the snow houses of the Arctic, the earth lodges of the northern interior, the brush tipis of the Cordilleran valleys, the cactus-protected grass houses of the Southwest, have been examined; the cliff houses of the western cañons, the cavate dwellings of the mesas, and the stone-walled or adobe villages of the arid region, have been made known and classified as to type and function; while the great mounds and extensive earthworks of the Mississippi valley and other portions of the continent have been subjected to survey in the field and comparative study in the office. A noteworthy report of the bureau is the memoir on American houses and

1 Defined in the Thirteenth Annual Report of the Bureau of Ethnology, 1896, pages 22–24.

2 "Casa Grande Ruin," in Thirteenth Annual Report of the Bureau of Ethnology, 1896, pages 289–319.

house-life[1] by Lewis H. Morgan, whose epoch-making researches concerning the social organization of primitive peoples marked him as a founder of demotic science; and the monograph on mounds and earthworks[2] by Doctor Thomas was the first complete demonstration of the relations of the long mysterious "mound-builders." The Mindeleff brothers and the Stevensons, as well as Professor Holmes and Mr. Cushing, also contributed much to knowledge of the native architecture of the Southwest through a dozen memoirs published in the reports.

One of the earliest lines of study related to aboriginal costumery; and it has been ascertained that the material, form, and construction of dress interacted constantly with artistic and other concepts. The relation between dress and decoration was pointed out by Holmes, who in a recent publication showed also that the prehistoric fabrics from caves and mounds were essentially similar to the fabrics found in use by the white discoverers.[3] The researches indicate that the construction of articles of dress depends primarily on material, yet at the same time reflects the culture-status of the dressmakers, thus expressing the intimacy of connection between local culture-grade and local environment.

When the Colorado was explored, and afterward when the bureau was instituted, much time and energy were devoted to the study of aboriginal handicraft through direct observation followed by comparison; it was soon found that the inferences of civilized students concerning the manufacture and use of primitive implements are frequently erroneous, since primitive thought is unlike cultured thought; and accordingly

[1] "Houses and House-Life of the American Aborigines," in Contributions to North American Ethnology, Volume IV, 1881 (a complement to his "Ancient Society").

[2] "Report on the Mound Explorations of the Bureau of Ethnology," in Twelfth Annual Report of the Bureau of Ethnology, 1894, pages 3–730.

[3] "Prehistoric Textile Art of the Eastern United States," in Thirteenth Annual Report of the Bureau of Ethnology, 1896, pages 3–49.

it was found desirable to transfer that branch of technology relating to primitive implements and weapons from a speculative to an observational basis. The work in this direction shaped the later operations of the bureau, and laid the foundation for most of the researches in archæology. Notable contributions to the scientific study of native American technology have been made by Professor Holmes, Doctor Thomas, and Mr. Cushing. Through the researches of these and other investigators it has been shown that native American art is essentially a unit, and that while more or less distinct phases sometimes overlap, the chronologic differences are no greater than the geographic differences found in passing from one portion of the continent to another. In brief, the researches indicate that at the time of the discovery the American people were in the stone age, though approaching the non-smelting age of metal; and that this age was indivisible, each of the known tribes making and using both crude and finished stone tools.

Incidentally it has been shown that study of the handicraft of primitive people affords the only key to prehistoric art, and that foreign inferences as to culture stages are inapplicable to the western hemisphere.

The native domestic wares have received much attention. The Stevensons, the Mindeleff brothers, and other collaborators made extensive collections of pottery, particularly in the Southwest, and these have been supplemented by the unprecedentedly rich collections of prehistoric ware made by Doctor Fewkes; and the collections have been successfully studied by Professor Holmes,[1] who has thereby traced the development of decoration, and by Doctor Fewkes, who has traced the growth of the mythic symbolism of the pue-

[1] Professor Holmes' investigations are summarized in memoirs on aboriginal stone art, in the Fifteenth Annual Report of the Bureau of Ethnology, pages 3–152, and on aboriginal pottery, accompanying the Sixteenth Annual Report (in press).

blos;[1] while Cushing has worked out several important stages in the development of the potter's art and of the associated symbolism.[2] The art of basketry is in many ways allied to that of pottery, and the decorative designs are alike significant. Much information has been gathered also concerning wooden-ware and gourd-ware. The researches show that the domestic arts of America are indigenous and essentially a unit, and that the art products cover the entire range from middle or lower savagery up to the borderland of feudalism. Fully a score of memoirs published in the reports deal with this subject.

In connection with the researches relating to native implements, weapons, and utensils, inquiry was made concerning the sources of the materials employed in the arts. As these inquiries were pushed, it was found that extensive quarrying and mining operations were conducted by the Indians in different parts of the country. Several collaborators were engaged in the work, notably Professor Holmes, who explored extensive aboriginal quarries on the Atlantic slope and in the interior, and examined the remarkable mines for copper on Lake Superior and for gold and mica in the Appalachians.

Researches concerning prehistoric works have recently been extended into Florida, chiefly by Mr. Cushing, and have been rewarded by the most remarkable discoveries in the history of American archæology; evidence has been found that the keys and coastal lowlands skirting the Gulf below the twenty-seventh parallel have been occupied, raised by ramparts of shells, indeed artificialized, by a powerful and well-organized sea-faring people; and the abundant implements, weapons, fabrics, and ceremonial objects found in the

[1] Doctor Fewkes' results are incorporated in the Seventeenth Annual Report of the Bureau of Ethnology (in press), and general papers in the Smithsonian Reports.

[2] "A Study of Pueblo Pottery as Illustrative of Zuni Culture Growth," in Fourth Annual Report of the Bureau of Ethnology, 1886, pages 473–521.

rampart-protected bogs afford a striking record of the characteristics of the people.

The games of the Indians have been carefully studied by several collaborators, and have been found to illustrate the natural history of amusement, and thus to form a basis for the science of esthetology. The simpler games have been found to be mimetic; commonly the diversion mimics the industry, whether it be the care of children or house on the part of the girl, or hunting, fighting, and racing on the part of the boy; while other games imitate social and religious observances. Some of the simplest amusements remain purely diversional; others develop into elaborate games and arts of pleasure. An important factor in modifying native games grows out of the mythologic tendency of the Indian mind; objects and forces which are not understood are deemed "mysterious" (transcendental or supernatural, so far as civilized language can express primitive concept), and thus the result of a throw, a race, or a shot is ascribed to fate, and through association effort comes to be regarded as an invocation. In this way the organized games become divinatory. This curious relation is well brought out in different publications by Mr. Cushing, Mr. Mooney, and Mrs. Stevenson, and in a recent memoir by Doctor Hoffman which deals with Indian jugglery.[1] Other lines of esthetic development lead toward graphic expression, and thus blend with decoration and eventually with pictorial and conventional symbolism, in which there is always a mythologic or divinatory element, as shown by Doctor Fewkes.

Major Powell's researches among the Indians of the Rocky Mountain region led to the discrimination of certain stages in the development of social organization. The most fundamen-

[1] "The Menomini Indians," in Fourteenth Annual Report of the Bureau of Ethnology, 1896, pages 3–328. See also *ibid.*, pages li–liv.

tal distinction brought to light was that between tribal society, which is organized on the basis of actual or assumed kinship, and national society, which springs from altruism and is commonly organized on a territorial basis. As the researches progressed it was ascertained that tribal society, as exemplified by the American Indians and other primitive peoples, comprises two stages: in the earlier stage, commonly styled savagery, kinship is reckoned in the female line, and the kindred are grouped in clans; in the second stage, which corresponds with barbarism as properly defined, kinship is reckoned in the male line, and the customary group of kindred is a gens. Both clans and gentes are grouped in tribes, and these groups may be combined in confederacies.[1]

Nearly all of the American Indians belong to the tribal stage of society, though it would appear that the germ of feudal organization existed among some Mexican and Central American peoples, and was fairly matured in Peru at the time of discovery. Circumstances have thus far prevented detailed study of the most advanced social organizations, but the lower types have received much attention. Most of the tribes of the United States have been found to follow the clan system, though many are gentile; it has been ascertained that the chieftaincy is usually hereditary, in clans or gens, and elective or selective among the individuals of the group on the basis of actual or assumed seniority. The greater part of the material accumulated and used in these studies is incorporated in a manuscript "Cyclopedia of Indian Tribes," now in preparation for the press chiefly by Mr. Hodge, though memoirs bearing on the subject have been published in several reports.

Soon after the researches among the Rocky Mountain In-

[1] The earlier results of this work are summarized in the Third Annual Report of the Bureau of Ethnology, 1884, pages xxxv–lxii.

dians began, Morgan's classic work on "Systems of Consanguinity and Affinity of the Human Family"[1] was published, and the principles enumerated therein were carefully submitted to the test of field observation during several successive seasons; and when the bureau was instituted a part of the researches followed the lines indicated in Morgan's treatise. In this way a large body of material relating to aboriginal kinship systems was accumulated and was utilized in the definition of stages in social development. It was ascertained that, while primarily real, the recognized kinship among primitive peoples is in part assumed, and that this assumption of kinship has far-reaching consequences, too numerous and complex for summary statement.

During the progress of the anthropological researches of the Rocky Mountain Survey, Major Powell ascertained that the Indians have a system of tribal laws which are notably fair, comprehensive, and efficient. In the absence of writing there are no statutes, yet through the intricate system of prescriptorial association the laws are perpetuated almost as completely as, and inculcated much more generally than, the statutes of civilized peoples; in nearly all tribes the code was crystallized in the tribal organization, in the names of individuals and groups, in kinship and marital relations, in form of salutation, in the position of individuals about the campfire and of camps in the group, in the points of the compass, in colors, in symbols on arrow-shaft or garment or habitation, and in many other ways. When the bureau was instituted, aboriginal law was found to form a fruitful field for research, and much information was collected. On comparing the facts discovered among many tribes, it was ascertained that the legal system of the Indians, while varying from place to place and from stage to stage in degree of development,

[1] "Smithsonian Contributions to Knowledge," 1871, Volume XVII.

and while often singularly elaborate in plan and execution, rests on a simple and definite basis; the primary purpose of all Indian law is to prevent or settle dispute, and thus to promote peace and the welfare of the group.[1]

When the bureau was instituted Director Powell gave careful attention to the subject of marriage, and ascertained that in America the forms known as endogamy and exogamy are simply two aspects of the same custom. In most tribes the laws relating to marriage are strict, and are regulated and enforced with prohibitions; and, while the regulations vary, it is a generally observed law that a man may not marry in his own clan, but must marry in his own tribe, when the marriage is commonly arranged by the council; so that the clan is exogamous, while the tribe is endogamous. Accordingly, so far as the American Indians are concerned, endogamy and exogamy are correlative terms, useful in description, but not expressing distinct stages in development. It was found that the regulations concerning marriage in the different tribes tend toward complexity, and that various devices are adopted to prevent them from becoming unduly onerous and inimical to tribal welfare: thus a prohibited marriage may be effected through elopement when, if the elopers are able to avoid vengeance for some period, the offense is condoned, and the couple eventually join the proper clan or gens; in some cases provision is made for settling rival claims to the hand of a woman by wager of battle; and in some cases there are regulations relating to marriage by capture, in which the ordinary prohibition is suspended. A result of the researches relating to marriage among the Indians is the discovery that the blending of clans, the union of gentes, the confederation of tribes, and in general the combination

[1] "Wyandot Government," in First Annual Report of the Bureau of Ethnology, 1881, pages 57–69. Third Annual Report of the Bureau of Ethnology, 1884, page lvii. "On Regimentation," Fifteenth Annual Report of the Bureau of Ethnology, 1897, pages civ–cxxi.

and demotic development of the people were brought about through intermarriage, partly spontaneous, partly regulated by common law, and sometimes adopted by leaders to terminate intertribal strife.[1]

The idea of property right was inchoate among the American aborigines, though moderately developed among the cultured people of the tropics and still clearer among some of the tribes in the Arctic, the natural home of thrift; and the many stages in development exemplified among the tribes have offered opportunity for making much progress toward elucidating the natural history of property right. The subject was extensively treated by Director Powell, with primitive law and marriage customs, in several early reports.

The initial researches showed that the distinction between opinions and beliefs among the Indians is vague, and does not agree with that found among cultured peoples. As the work progressed it was ascertained that the Indian philosophy and belief are fundamentally mystical. Among many tribes objects are vaguely supposed to have mysterious doubles in a vague ideal counterpart of the actual world, and the unknown is invested with shadowy and illimitable potency; and all of the Indians so far investigated carefully have been found to be mystics. The all-pervading "mystery" of Indian belief is hardly susceptible of definite translation into civilized language, since the concept pertains to the prescriptorial stage of thought. Several stages in the development of the primitive belief have been discovered and subjected to comparative study, chiefly by Powell, and thereby light has been thrown on the natural history of sophiology. The earliest clearly defined stage is that in which mysterious potencies are imputed to all objects, inanimate

[1] "Tribal Marriage Law," in Third Annual Report of the Bureau of Ethnology, 1884, pages lvi–lxii.

and animate; this has been called hecastotheism. In the second definite stage the mysterious potency is limited generally to animate forms, though sometimes extending to plants and rarely to inorganic things; this has been called zoötheism. Most of the tribes were in the higher of these stages, and their belief was bound up with every-day conduct and social organization in curious fashion. One expression of the belief was found in the clan nomenclature: nearly every clan or gens bore the name of an animal tutelary, and a picture of, or conventional symbol representing this animal was used as a clan totem. Some of the tribes were found to have advanced partly into the third stage of belief, in which the forces of nature are personified or deified; this is physitheism. Contrary to a popular notion originating in the secretiveness and shrewdness of the Indians with respect to matters of belief, it was ascertained that none of the native peoples thus far studied with care have advanced to the stage of spiritual concepts, or of psychotheism. With the qualifications and limitations thus implied, all of the American tribes have been found to be polytheistic. Numerous publications relating to this line of work, in which several collaborators aided, have been issued; notably Powell's "Sketch of the Mythology of the North American Indians,"[1] the basis of the later work.

The beliefs of the Indians are crystallized in symbols and ceremonials, which are often highly elaborate. The simpler symbols, or fetiches, usually represent zoic deities; these are adored through the symbols which, although held to be sacred, are not in themselves objects of worship. Commonly the fetiches are crude, vaguely suggesting, through prescriptorial association, the characteristics ascribed to the deities; among some tribes the beast-gods are more defi-

[1] First Annual Report of the Bureau of Ethnology, 1881, pages 19-56.

nitely represented by carvings and paintings, often in the form of masks; among the Pueblo people and the advanced tribes of Mexico and Peru the deities were considered anthropomorphic or zoömorphic at will, and were sometimes represented by idols of human form, either normal or monstrous, symbolizing the personages of the barbaric pantheon. The more important symbols are intrusted to shamans or priests, who become sacred through association, and are kept in sacred places, sometimes developed into temples; among many tribes the priesthood is an important and even dominant class. The simpler rights appear in every-day conduct; higher ceremonials are oblations in the presence of the fetiches, and these culminate in sacrifice of property, or of animal and even human life. The ordinary ceremonial is individual, but among the tribes investigated there are elaborate collective ceremonials usually extending over several days, and occurring several times annually. In general, the Indians are profoundly devout believers, whose faith controls action in greater degree than is realized in higher culture.

Under the terms of law the collections made by the bureau are transferred to the United States National Museum; and it has been found convenient and profitable to maintain intimate relations with that branch of the Institution and constantly to base the laboratory researches on the anthropological material from all sources stored in the museum. Extensive collections have been made directly for the enrichment of the museum as an assemblage of objective material relating to the American Indians. The collections made by Director Powell while in charge of the Rocky Mountain Survey are particularly noteworthy; they comprise implements and weapons, costumery, gaming devices, symbolic and ceremonial objects, and are especially rich in native vegetal food-substances; they may be considered to form the

nucleus of the ethnologic department of the museum. Ample collections were made also by the Stevensons, by Professor Holmes and Mr. Mooney, and by other collaborators; recently Doctor Fewkes has gathered unprecedentedly abundant stores of decorated pottery from the Pueblo country; and the writer has added some unique material from the Papago country, as well as from the interior of Seriland, never before visited by white men.

The publications issued to date comprise fourteen annual reports embracing fifty-nine appended memoirs (three additional reports, embracing twelve memoirs, are in press); twenty-four bulletins, each containing a special paper or memoir; eight volumes of "Contributions to North American Ethnology"; four "Introductions" issued for the use of correspondents and collaborators; and a few miscellaneous documents.

The manuscript collections are voluminous. Under the plan of limiting publication to important descriptive matter and to thoroughly digested scientific results, the major part of the observations remain unpublished, though in constant use. The unique manuscripts and most of the original records are kept in fire-proof vaults under more than two thousand titles; the material for the "Cyclopedia of Indian Tribes" is recorded on a hundred thousand cards; and there are several hundred manuscripts prepared by the Director, the different collaborators, and many correspondents which are not catalogued. Advantage has been taken of every opportunity to make or acquire photographs of Indians and their works; and the files now include about twenty-five hundred portraits, with some twenty-five hundred groups, houses, ceremonials, and other subjects. During the last three years publication has been pushed forward more rapidly than hitherto, for it is realized that the material pertaining to

most lines of research is now sufficiently voluminous to warrant thorough study and final issue.

These paragraphs do no more than touch lightly on salient points in the history, policy, and work of the Bureau of American Ethnology. The field is vast, and the lines of research are many; and it has ever been the aim of Director Powell and his collaborators so to select and pursue lines of work as to aid in creating and diffusing among men definite knowledge concerning the American aborigines as one of the great branches of mankind. Accordingly the small library of reports published and the small assemblage of objects collected through the work of the bureau contribute toward the memorial to Smithson, the founder, and Henry, the organizer, of the parent institution of American science. At the same time the work of the bureau is a tribute to the foresight, liberality, and wisdom of the statesmen who have endowed and sustained the "researches concerning the American Indians."

THE INTERNATIONAL EXCHANGE SYSTEM

BY WILLIAM CRAWFORD WINLOCK

THE "diffusion of knowledge," which, next to its "increase," was so prominently in the mind of the founder of the Smithsonian Institution, was provided for in the program of organization, submitted by Professor Henry to the Board of Regents in 1847, by a system of publications and their exchange[1] and distribution throughout the world.

In his report for 1851 Professor Henry describes the exchange system, organized for the purpose of distributing the first volume of the Institution's publications, as an extension of a system which had then been in operation, on a small scale, for nearly half a century between the American Philosophical Society and the American Academy of Arts and Sciences on this side of the Atlantic, and several scientific societies abroad. While the Smithsonian Institution exchanges had no direct connection with those established

[1] Reference should be made to a "History of the Smithsonian Exchanges," by George H. Boehmer, printed in the "Smithsonian Report" for 1881. Mr. Boehmer had also prepared the manuscript for a more complete history of the exchange service with copies of official documents relating to its development. This manuscript has been consulted in the preparation of the following brief account of the exchanges.

between national governments by Vattemare,[1] it soon superseded all other plans for international exchanges.

It is not without interest to briefly allude to the earlier efforts of this kind. In 1694 the Royal Library of France exchanged its duplicate volumes for new books printed in foreign countries, and about the beginning of the present century the American Philosophical Society and the American Academy of Arts and Sciences instituted the exchange to which Professor Henry refers.

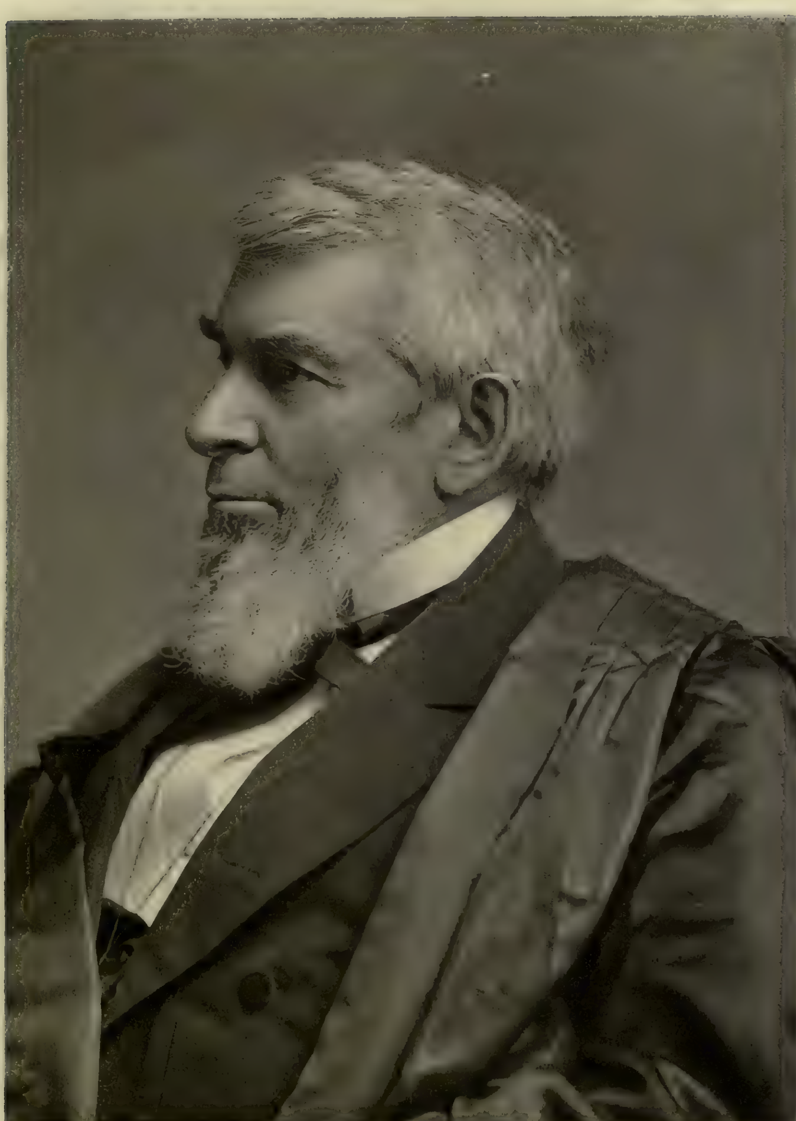
Monsieur Vattemare about 1832 made an effort to establish an exchange of duplicates between some of the principal libraries of Europe, and succeeded in interesting many of the governments in the work, though his efforts do not seem to have been rewarded with the success they merited.

He visited the United States in 1839, and secured the interest and coöperation of many prominent men in official life. On his second visit to the United States in 1848 he was designated as the agent for the Library of Congress to conduct the exchange between France and the United States.

Another effort to establish a system of exchanges, chiefly of natural history specimens, was made by the National Institute in May, 1840, which resulted in securing many valuable additions to the national collection.

The United States government, in addition to assisting Monsieur Vattemare, had on several occasions indicated its desire of effecting exchanges with foreign governments. By

[1] Alexandre Vattemare was born in Paris November 8, 1796, and died there April 7, 1864. He was educated as a surgeon, but became a professional ventriloquist, being well known both in Europe and America. Subsequently he gave up this occupation to urge the adoption of a system of exchange of duplicate books between libraries, especially of government publications, but afterward extended the system to include art objects, maps, specimens of natural history, and other similar articles. He came to the United States in 1839, and again in 1847. He is credited with being the means of adding 300,000 volumes to the libraries of this country. The correspondence of M. Vattemare with the National Institute, in which he has set forth at some length the progress of his plan for international exchanges, will be found of much interest.



the Act of July 20, 1840, the Librarian of Congress was authorized to exchange duplicates in the library for other books or works. By the act of March 4, 1846, he was directed "to procure a complete series of reports of the United States Congress and of the laws of the United States, and transmit them to the Minister of Justice of France, in exchange for works of French law presented to the United States Supreme Court." "By a resolution of June 30, 1848, it was ordered that the joint committee on the library be furnished with twenty-five copies of the Revolutionary archives, twenty-five copies of Little and Brown's edition of the "Laws of the United States," and seven copies of the exploring expedition, then published, and an equal number of subsequent publications on the same subject, for the purpose of international exchange."[1]

The first volume of Smithsonian publications issued was a memoir on the ancient monuments of the Mississippi Valley by Squier and Davis, published in 1848 and distributed in the following year. It was found that after agencies were established in different parts of the world for the exchange of the Institution's own publications, other exchanges could be carried on through them at slight additional expense, and the Smithsonian Institution accordingly offered to other institutions of learning, and in some cases to individuals, the privilege of sending and receiving small packages through these agencies.

The plan of conducting the foreign exchange was to issue at stated periods a circular to the effect that the Smithsonian Institution was then making preparations to send copies of its publications to the different libraries and societies in Europe and other parts of the world, and that it would undertake

[1] "Public Libraries in the United States of America, their History, Condition, and Management." Special Report, Bureau of Education, 1876, part 1, page 284.

the transmission and safe delivery of the publications of other American institutions, in accordance with certain rules, providing, in effect, that the packages should be properly wrapped, addressed, and delivered to the Institution in Washington accompanied by a detailed invoice.

No charge was made for the expense of sending from Washington if the parcels were of moderate bulk, though the right to make a charge proportional to the actual expense incurred by the Institution was reserved in some instances.

These facilities soon proved of such value that the exchange service assumed a much wider importance than could have well been anticipated, though, as far as the exchange of the Smithsonian publications proper was concerned, the principal object was not so much to procure a large library for the Institution as to diffuse among men a knowledge of the new truths discovered by the agency of the Smithsonian fund.

Professor Henry said in 1852:[1]

"The worth and importance of the Institution are not to be estimated by what it accumulates within the walls of its building, but by what it sends forth to the world. Its great mission is to facilitate the use of all the implements of research, and to diffuse the knowledge which this use may develop. The Smithsonian publications are sent to some institutions abroad, and to the great majority of those at home, without any return except, in some cases, that of coöperation in meteorological and other observations.

"In carrying out this plan, the Institution is much indebted to the liberal course adopted by the government of Great Britain, and to the ready coöperation of the Royal Society of London. All packages intended for Great Britain, for some parts of the continent, and the East Indies, are directed

[1] "Smithsonian Report," 1852, pages 20 and 21.

to the care of the Royal Society, and, on the certificate of its President, are, by a special order of the government, admitted duty free, and without the delay and risk of inspection."

And in 1854:[1]

"There is, therefore, no port to which the Smithsonian parcels are shipped where duties are charged on them — a certified invoice of contents by the Secretary being sufficient to pass them through the custom-house free of duty. On the other hand, all packages addressed to the Institution, arriving at the ports of the United States, are admitted, without detention, duty free. This system of exchange is, therefore, the most extensive and efficient which has ever been established in any country."

An essential feature of the organization of the Smithsonian exchange service was to secure the coöperation of an important scientific society or permanent library in the principal foreign countries willing to undertake the distribution of the publications it might receive for institutions in its neighborhood. In many instances, also, members of the diplomatic and consular service of the United States rendered efficient aid, and several prominent publishing houses likewise acted as local agents.

The following communication[2] from Sir Edward Sabine, who later became President of the Royal Society, shows the deep interest manifested in this movement:

"Royal Society's Apartments,
"Somerset House, London, March 19, 1852.

"My Dear Sir:

"I duly communicated to the Earl of Rosse, President of the Royal Society, your letter to me on the subject of the inter-

[1] "Smithsonian Report," 1854, page 21.

[2] Rhees, William J. "The Smithsonian Institution: Journals of the Board of Regents, Reports of Committees, Statistics," etc. Washington, 1879, page 82. Also Boehmer, George H., "History of Exchanges," page 11.

change of scientific publications between the United States and this country, and the admission into England, duty free, of scientific books and memoirs presented to institutions or to individuals here, either by or through the Smithsonian Institution. I accompanied this communication by a letter addressed to the President, which you will read in the enclosed printed minutes of the Council of the Royal Society of January 15, 1852. The subject has since been brought by the Earl of Rosse under the consideration of Her Majesty's government, who have shown, as might be expected, much readiness to meet, in the same spirit, the liberal example which has been set by the United States, in exempting from duty scientific books sent as presents from this country to the Smithsonian Institution, and through that Institution to other institutions, and to individuals, cultivating science in the United States. The mode which has been suggested by our Board of Customs, for admitting duty free scientific publications designed for this country, and which, we hope, will receive the approval of the Treasury, is, that a list should be furnished by the Royal Society of the names of all institutions and individuals to whom such works may be expected to be addressed, when the custom-house officers will have directions to pass without duty all such publications having the names of such institutions or persons inscribed either on the cover or on the title-page, which are sent to this country in packages directed to the Royal Society — the list to be amended or extended from time to time. The Royal Society will gladly take charge of and distribute under these regulations the books which the Smithsonian Institution may send for institutions and individuals in this country, receiving them from the agent in London appointed by the Smithsonian Institution; and I shall be obliged by your furnishing me, at your earliest convenience, with a list, as complete as you may be able to make it, of the names of the institutions and persons to whom books or memoirs are likely to be sent.

"The Royal Society will also gladly receive and forward to their ultimate destination (where such assistance may be useful) packages containing publications of a similar description,

designed for institutions and individuals on the continent of Europe; such packages being directed to the Royal Society, and stated on the outside of the case or package to be *from the Smithsonian Institution.* The customs' duties will, in such cases, be either altogether remitted or returned on re-exportation.

"If it be a convenience to the cultivators of science in the United States, that publications presented to them by institutions or individuals on the continent of Europe, or elsewhere, should be addressed to the Royal Society as a channel of communication, the same facilities will be given by the Board of Customs, and the Royal Society will, with pleasure, make the required arrangements. It will be necessary, in such cases, that packages arriving from the continent of Europe or elsewhere should be marked on the outside, *for the Smithsonian Institution*, and the foreign Secretary of the Royal Society should be apprised of their being sent. Expenses of freight would of course be defrayed by the agent of the Smithsonian Institution.

"I remain, my dear sir, with great respect and regard,

"Very sincerely yours,

"EDWARD SABINE,

" *Vice-President and Treasurer of the Royal Society.*"

An interesting special use of the exchange system took place in 1867, when, at the suggestion of the Honorable John Bigelow, a former Minister to France, a request was made by the Institution that some of the principal publishers of school-books in this country should furnish copies of their elementary text-books, in order that they might be presented to Professor Laboulaye, of the College of France, for examination, with a view to the application of some of their peculiar features to the purposes of instruction in his own country. In response to this request, nearly two hundred volumes of school text-books were furnished by the princi-

pal publishers in the United States, and received with warm thanks by Professor Laboulaye.

In recognition of the disinterested work of the Institution, many of the principal steamship companies granted to it important concessions in free freight, and without this friendly aid the system could scarcely have grown to the proportion it has now attained. Among others the Secretary made special acknowledgment in earlier years of obligations to the United States Mail Steamship Company, the Panama Railroad Company, and the Pacific Mail Steamship Company; to the North German Lloyd, to the Cunard Steamship Company, and to many of the principal publishing houses in this country.

The Royal Society, after acting as the agent of the Institution for several years, found in 1862 the constantly increasing duties of distributing exchanges somewhat burdensome. It was, therefore, deemed necessary to establish a salaried agency at the expense of the Institution, to be located in London, for Great Britain and its colonies. Messrs. William Wesley & Son, booksellers, at 28 Essex Street, Strand, were appointed the London agents.

For the same reason that made a change necessary in the administration of the affairs of the Institution in Great Britain, Doctor Felix Flügel, of Leipsic, was appointed to attend to exchange matters between Germany and the United States, and subsequently exchanges between the United States and Austria-Hungary and also Switzerland, were conducted through the Leipsic agency.

With the exception of the agencies of the Institution in Great Britain and Germany, there are at present no salaried officers of the Institution in foreign countries, all transactions being conducted gratuitously, either by foreign official exchange bureaus or by libraries or scientific institutions which

have willingly assumed the task for the benefit that may accrue from the service.

So useful had this exchange system become within the first ten years of its existence that in 1855 the following communication[1] was forwarded by Professor Asa Gray, the Secretary of the American Academy of Arts and Sciences, to Professor Henry:

"AMERICAN ACADEMY OF ARTS AND SCIENCES,
"BOSTON AND CAMBRIDGE, MASSACHUSETTS,

"August, 1855.

"MY DEAR SIR:

"The following extract from the record of the annual meeting in May last has just been furnished me by the recording secretary:

"'Professor Agassiz referred to the allusion in the librarian's report to the Smithsonian Institution, and expressed in strong language his sense of indebtedness of the scientific world to that Institution, for its enlightened efforts to diffuse knowledge, particularly as a medium of exchange of publications. In conclusion, he moved *that the thanks of the academy be presented to the Smithsonian Institution for its efficient agency in effecting for the academy its exchanges with societies and individuals*, which was unanimously adopted.'

"I have great pleasure in forwarding to you the vote of the academy, in obedience to its instructions.

"And I remain, very respectfully,

"Your obedient, faithful servant,

"ASA GRAY,
"*Corresponding Secretary.*"

The Smithsonian exchange service was early taken advantage of by the bureaus of the United States government to effect the distribution of their technical publications to

[1] "Smithsonian Report," 1855, page 79.

foreign libraries and the collection of similar reports in return, and between the years 1851 and 1867 it is estimated that over twenty thousand packages of such government publications were carried by the exchange service, at an approximate cost to the private fund of the Institution of over eight thousand dollars.

The government exchanges, however, were in a chaotic condition until the enactment of a joint resolution, approved March 2, 1867, that fifty copies of all documents printed by order of either House of Congress, or by order of any department or bureau of the government, should be placed at the disposal of the joint committee on library, who should exchange the same, through the agency of the Smithsonian Institution, for similar works published in foreign countries; these works to be deposited in the Library of Congress.

Respecting this system Professor Henry said[1] in 1870, in his testimony concerning the expenditure of the Smithson fund, before an English government scientific commission, of which the Duke of Devonshire was chairman and Sir John Lubbock and Professor Huxley members:

"There is one part of the operations which I have not sufficiently dwelt upon, and that is the system of international exchanges. In order to send the volumes of Smithsonian Contributions over the world, the Institution has agents; an agent in this city, an agent in Paris, an agent in Leipsic, an agent in Amsterdam, and another in Norway; and every year the volumes of the Institution are sent to these agents for distribution, and with them the transactions and proceedings of all the societies of the United States, and also of Canada, and of South America. For example, all the Canadian institutions send copies of their publications to the Institution, and then the Institution distributes them over the world, and receives in return for the several donors the pro-

[1] Rhees, William J. "Journals of the Board of Regents," etc., page 782.

ceedings and transactions of foreign societies. This part of the operations costs about £1,000 sterling a year, but it is considered of great importance in the way of making science one in all countries. This is considered a very important part of the plan of operations. Not only are books distributed, but the Institution has commenced the practice of distributing specimens of natural history over the world and getting others in exchange. As an interesting fact in connection with this system, I may mention that all the lines of steamers, the Cunard line of steamers, the German Lloyds' steamers, and the lines from San Francisco, all convey the Smithsonian packages free of cost, and also that they are admitted through all custom-houses without being opened, and free from all duties in all countries.

"Doctor Sharpey: Do you receive for the societies in America, for example, from the societies in London, and distribute those exchanges to the societies in America?—Yes, for all the societies. The great object is to facilitate in every possible way the promotion of science, and especially the fostering of original research, and enlarging the bounds of human thought. It is a matter of surprise that the idea is not more generally understood by statesmen and legislators, that modern civilization depends upon science, including the knowledge of the forces of nature, and the modes in which they become the agents of man. Every discovery is connected with good. Even the human body cannot be properly understood without a knowledge of that of all other organized beings."

The resolution of Congress carried no appropriation, so that it was not until 1873 that the exchange actually began, and its operation was necessarily restricted, owing to the large drain made upon the funds of the Institution. Nevertheless, Mr. Ainsworth R. Spofford was enabled to say of this work in 1876[1] that "the Smithsonian Institution has

[1] "Public Libraries in the United States of America, their History, Condition, and Management." Special Report, Bureau of Education, 1876, part 1, page 684.

rendered incalculable service to the scientific development of this country through its broad and liberal system of exchanges with learned societies throughout the world." And in 1881[1] Professor Baird stated that

"No one of the various operations carried on by the Smithsonian Institution is of more importance in the advancement of science than that of the international exchange of publications between the governments and their bureaus, departments, the learned institutions, and scientific men of the two worlds. Notwithstanding the increase of the governmental international system, in which quite a number of nations have joined, the work of the Smithsonian Institution still continues to be of preëminent magnitude and importance. Originally initiated for the purpose of distributing the publications of the Smithsonian Institution to libraries, societies, and learned men abroad, and to receive returns for the same, it was gradually extended so as to take within its sphere all the establishments in the New World requiring a similar service. Indeed, by its system of agencies in various portions of the world to which packages were sent for transmission to destination, and where returns were gathered and forwarded to Washington, it maintained an arrangement of its own, entirely independent of any other organization."

Congress had, as already mentioned, even as early as 1840, taken into consideration the exchange of its documents for similar works of foreign governments, and, as the result of Monsieur Vattemare's efforts, in 1846 provision was made for exchanging a complete set of the laws of the United States with the French government, while in 1848 the joint committee on the library was authorized to appoint exchange agents for the exchange of books and public documents for the use of the United States, for any single State, or for the

[1] "Smithsonian Report," 1881, page 30.

Academy in West Point, or for the National Institute — all these to be admitted free of duty.

Special acts for the exchange of specific volumes were passed in 1848, 1849, and 1856, but the first general law for the exchange of United States documents was that enacted in 1867, a joint resolution being approved on March 2 of that year to the effect:

> "That fifty copies of all documents hereafter printed by order of either House of Congress, and fifty copies additional of all documents printed in excess of the usual number, together with fifty copies of each publication issued by any department or bureau of the government, be placed at the disposal of the Joint Committee on the Library, who shall exchange the same, through the agency of the Smithsonian Institution, for such works published in foreign countries, and especially by foreign governments, as may be deemed by said committee an equivalent; said works to be deposited in the Library of Congress."

While this resolution carried with it no appropriation, Professor Henry at once undertook the preliminary correspondence necessary to carry it into effect by addressing a circular letter, through the Department of State, to the diplomatic representatives of the United States and foreign countries and to the foreign ministers accredited to this government, stating the object of the resolution, and asking the coöperation of foreign governments in carrying it out. To this circular letter very general and satisfactory replies were received, each government responding offering to send complete series of its publications in return for those of the United States. It was not until 1873, however, that the first transmission of documents abroad was made by the Institution.

In 1875 an International Geographical Congress was held

in Paris, at which was discussed, as a matter closely allied to the main objects of the Congress, a uniform system for exchanging the scientific and literary publications of all countries. The commission, under the presidency of Baron de Vatteville, submitted to the different governments represented, a detailed plan for international exchanges, and in 1878, as the result of correspondence between the Smithsonian Institution and the Department of State, the Institution was recognized by the Secretary of State as the special agent for the United States government to carry out the suggestion of the convention, which involved not only the exchange of official documents, but of the publications of learned societies as well, the exchange of official documents with the governments represented being, in the case of the United States, for the benefit of the Library of Congress.

Further conferences upon the subject were held in Brussels in 1877 and 1880, and again, after six years' experience of the working of the plan proposed in Paris, a general conference was called by the Belgian government in 1883. The United States government was represented at this latter conference by its resident minister, Honorable Nicholas Fish, and later by his successor, Honorable Lambert Tree, and the draft of articles of agreement for the international exchange system proposed was in due time communicated by the Department of State to the Smithsonian Institution for criticism. These articles of agreement having been submitted to the contracting powers, a conference was called in Brussels on March 15, 1886, at which they were signed by duly accredited diplomatic representatives, and the convention was laid before Congress and ratified by the President July 19, 1888. Ratifications were finally exchanged, and the convention was proclaimed by the President on January 15, 1889. There were, in fact, two conventions adopted, the first for the

"International Exchange of Official Documents, Scientific and Literary Publications," and the second for the "Immediate Exchange of the Official Journals, Parliamentary Annals and Documents" of the States interested.

The first convention was entered into by Belgium, Brazil, Italy, Portugal, Servia, Spain, Switzerland, and the United States. Its essential provisions were that each State should establish an Exchange Bureau, and should provide for the interchange of the respective official documents, parliamentary and administrative, and other works executed at government expense, each State assuming the cost of packing and transportation to the place of destination, except that where the transmissions were to be made by sea special arrangements might regulate the share of expense to be borne.

It was also provided that the official exchange bureaus should act as intermediaries between the learned bodies and literary and scientific societies of the contracting States, for the reception and free transmission of their publications.

The second convention, which was adopted by the same countries, with the exception of Switzerland, provided for the transmission to the legislative chambers of each contracting State immediately upon publication of copies of the respective official journals and the parliamentary annals and documents that are made public.

To these conventions Uruguay and Peru subsequently gave their adherence, so that there are now ten States, including the United States, under treaty obligations to maintain exchange relations. The carrying out of this obligation on the part of the United States, as far as the first treaty was concerned, did not change the prevailing conduct of the exchange service carried on by the Smithsonian Institution. To the second treaty, the immediate exchange of official journals, effect has not been given by the United States

through lack of legislation placing the necessary documents at the disposal of the Exchange Bureau and making an appropriation for the clerical assistance and postage; nor has this treaty apparently been fully carried out, as yet, by any of the contracting nations.

The absence of several of the principal nations — England, France, Germany, and Russia — from the treaty will be noted; but with these countries, as the result of the informal agreement reached with the Institution under the act of Congress of 1867, special exchange relations have been maintained by the United States, and in France and Russia the governments support official exchange bureaus as part of their administrative service, while between England and Germany and the United States special arrangements have been made for the exchange of official documents, though with none of these countries, with perhaps the exception of England, is there any approach to an official exchange at all equitable to the United States — a condition, in part, due to the fact that no country publishes on so liberal a scale as our own. That this may, perhaps, be remedied by personal representation to the many and scattered publishing offices of foreign governments seems probable from the results secured in 1885, when Mr. George H. Boehmer, as representative of the Library of Congress and of the International Exchange Office, visited many of the principal countries of Europe, and secured a large number of documents for the Library of Congress.

The Institution now receives fifty sets of all documents issued by the Government Printing Office, and despatches to foreign countries forty-three sets. Each country receives in four instalments an average, annually, of about two hundred and thirty-one volumes, and three hundred and seven pamphlets, the transmissions being made to the designated gov-

ernment library corresponding to our own Library of Congress.

The entire cost of the exchange service was borne at first by the Smithsonian fund, although from the very first the facilities of the service were placed at the disposal of government bureaus engaged in scientific work. An idea of the increase in the cost may be had from a glance at the accounts of expenditures for this purpose, which shows that from 1846 to 1850 the cost of exchanges was $1,603. For the year 1860 alone it was $2,348.04. In 1870 it had grown to $4,165.62. In 1876 the distribution of government documents was first made extensively, and the cost increased to $10,199.10, while in 1885 it was $13,307.59, and in 1895, $16,997.99.

The Institution continued to maintain the exchange service at its own expense until 1881, when the first appropriation of $3,000 was granted by Congress; and without reference to aid given by the Institution to government bureaus for their exchange service between 1851 and 1867, during which period it is estimated that over twenty thousand packages of publications were transported for the national government, at a cost of about $8,000, from January 1, 1868, to June 30, 1886, the Institution advanced for the support of the International exchange system in the interest and by the authority of the national government, $38,141.01 in excess of the appropriations for the exchange of official government documents and $7,034.81 in excess of appropriations from July 1, 1886, to June 30, 1889, for the purpose of carrying out the convention entered into by the United States—an aggregate advance of $45,175.82.

As now conducted, the rules for the control of the exchange service provide, in addition to the distribution of the United States government publications to foreign libraries, for the

distribution to certain accessible points abroad of books, pamphlets, charts, and other printed matter sent as donations or exchanges from literary and scientific societies or individuals to correspondents abroad, and involve no expense to the sender beyond that of delivery to the Smithsonian Institution in Washington. No charge is made to the receiver, except in some instances the small cost of delivery from the Smithsonian agent or correspondent nearest him. Similar material sent from abroad to this country is forwarded to the recipient without expense to him, the packages having been delivered free of freight charges to the foreign agent or correspondent of the Institution. The Institution is, by special act of Congress, enabled to transmit packages in this country under frank.

To describe somewhat more in detail the methods now employed in the Exchange Office, I would say that a scientific society or individual in the United States desiring to send publications abroad as donations or exchanges should have each package transmitted strongly wrapped and separately and legibly addressed, being careful to give the full local address, and should send them in bulk, carriage prepaid, to the Smithsonian Institution in Washington. The separate packages should not exceed one-half of one cubic foot in bulk, and they should not contain letters or written matter.

Before transmission, a list of packages, with the address on each package, is to be mailed by the sender to the Smithsonian Institution when sent from the United States, or to the foreign agent of the Institution when sent from abroad. The Institution must be informed by mail of each sending on the day of transmission.

Upon the receipt of the consignment at the Institution each package is assigned an "invoice number," the same number

applying to all packages of that consignment, and a record is made of the entire list of packages under the sender's name. The separate packages are also entered under the name of the person or office addressed. An account is thus established with every correspondent of the Institution, which shows readily what packages each one has sent or received through the Exchange Bureau. The books are then packed with invoices from other senders, and are forwarded by freight to the bureau or agency abroad which has undertaken to distribute exchanges in that country. To Great Britain and Germany, where paid agencies of the Institution are maintained, shipments are made about three times a month; to other countries at greater intervals.

Each package sent out contains a receipt card bearing an "invoice number" identical with that upon the package. This invoice number should be carefully noted, as it is the only means of identifying the package, and it is of the greatest importance that the recipient should sign and return the acknowledgment without delay. The receipt having been filed in the Exchange Office the record of that particular package is made complete, while failure to return the receipt card gives rise to a doubt as to the correctness of the address, and future packages for that address may be returned to the sender.

Transmissions from abroad are received by freight in large boxes and are distributed in the United States under frank by registered mail, a record first having been made of the name of the sender and of the address of each package. A receipt card, returnable by mail without postage, is sent with each of these packages, and should be forwarded at once by the recipient in acknowledgment of the package.

The Institution and its agents will not knowingly receive for any address purchased books, nor apparatus and instru-

ments, philosophical, medical, etc. (including microscopes), whether purchased or presented; nor specimens of natural history, except where special permission from the Institution has been obtained.

The first volume of "Smithsonian Contributions to Knowledge" was distributed in 1849 to 173 foreign institutions, virtually representing the Institution's foreign exchange work at its inception.

In 1852, the first year for which any detailed report of the exchange operations is given, 572 packages were sent out by the Institution and 637 packages were received, though each of the packages sent and received may embrace several "articles." In 1860 a total of 4822 packages passed through the Exchange Office; in 1870, 5510; in 1880, 20,845; in 1890, 82,572; in 1895, 107,118—the entire weight in 1895 being 326,955 pounds, or about 164 tons.

It is difficult, without the actual presentation of statistical tables, to give an adequate idea of the result of this exchange system. Moreover, prior to 1885, when the government exchange may be fairly said to have been begun, and when Congressional appropriations enabled the Institution to employ a force which allowed of the collection of proper statistics, 390,488 titles were received from all sources abroad for the libraries of the United States; of which 217,140 came to the Library of Congress, the library of the Smithsonian, and the libraries of the various departments and bureaus of the government, 136,810 to various institutions throughout the country, and 36,538 to individuals.

During the past decade accurate statistics have been kept not only for the entire country, but for the various States in the Union. If I had space to discuss them, the figures would present some most interesting features. Roughly, it may be said that the number of titles received

from foreign countries and distributed to institutions and individuals in the United States from 1886 to 1895 bordered upon 344,078, being almost equivalent to the activity of the previous forty years, and fully justifying the treaties made by the United States and the expenditure incurred. It should be noted, however, that the return to this country from foreign countries is by no means equivalent to the quantity sent abroad, since during the same period 601,637 titles were sent by the government, by institutions, and by individuals of the United States for foreign distribution. The list by States is most instructive. In the shipment abroad the District of Columbia naturally leads, the older States with many institutions heading the list. Massachusetts stands first, New York second, Pennsylvania third, and Connecticut fourth. It is a matter to be noted, and one in every way commendable to the scientific activity of the great State on the Pacific Coast, that California stands fifth in this list, being closely followed by Illinois; Missouri follows, Maryland stands next, being followed successively by Ohio and Wisconsin. The returns are even more instructive; and, strangely enough, the order in returns does not agree with the order in the amount of sending. In this second list the District of Columbia, as before, leads, Pennsylvania following, succeeded by New York, Massachusetts, California, Missouri, Minnesota, Maryland, Wisconsin, and Connecticut.

Without entering into the detail of the clerical work of the office, it will be sufficient to say that a ledger account is kept with each individual or institution from which a package is received in the Exchange Office, or to which a package is sent, the record identifying the sender as well as the receiver. To facilitate this work and abbreviate the records, there was compiled and published in 1862 a list of foreign addresses,

arranged geographically, and including the principal libraries, societies, and government offices and journals with which the Institution was in correspondence. To each of these titles an arbitrary number was given for the sake of convenience of reference. A revision of this "List of Foreign Correspondents of the Smithsonian Institution" was made in 1895 by Mr. George H. Boehmer, and it now embraces 10,765 libraries and 12,643 individuals — a total of 23,408 addresses, distributed in 3771 different cities or places.

The courtesy of many of the great transportation companies in extending to the exchange service the privilege of free freight has been continued even to the present day, and the assistance that has thereby been rendered to the Institution, and indirectly to libraries and scientific institutions throughout the world, cannot be overestimated.

The influence that the Smithsonian Institution has exerted through its international exchange service upon other institutions of learning at home and abroad, and how far its aim in the diffusion of knowledge has been accomplished by the methods whose history for half a century has here been sketched, are touched upon elsewhere. The enrichment of its own library has been but incidental. It can safely be said that no large library in the world has not experienced its benefits, while individual workers in science have been reached upon the very outskirts of civilization, and have been afforded encouragement and aid, and the means of communicating with their fellow-workers for half a century.

THE ASTROPHYSICAL OBSERVATORY

By Samuel Pierpont Langley

IN the view of one of those who did much to shape the early history of the Smithsonian Institution,—President John Quincy Adams,—no more prominent object could be designed for the expenditure of the Smithson bequest than the erection and maintenance of an observatory—an institution which would be local in its site only, and devoted to objects in which all men were interested.

In the bill[1] introduced at his instance to provide for the disposal and management of the Smithson fund, it is enacted that part of the accruing interest be appropriated toward the erection and establishment in the city of Washington of an astronomical observatory adapted to the most effective and continual observations of the phenomena of the heavens, to be provided with the necessary, best, and most perfect instruments and books, for the periodical publication of the said observations, and for the annual composition and publication of a nautical almanac.

A like clause appears in a subsequent bill,[2] and though

[1] House of Representatives, No. 386, Twenty-seventh Congress.
[2] House of Representatives, No. 418, Twenty-eighth Congress.

neither of these bills became law, it is well to remember how strenuously the application of the Smithson fund to this purpose was urged at the time when the Institution was taking the shape it now bears.

At the time that President Adams submitted these bills astronomy had departed little from the beaten track in which it had moved for centuries, and in which its main object had been to fix with precision the places of the heavenly bodies, without determining their nature. As the writer has elsewhere said:

"The prime object of astronomy until lately has been to say *where* any heavenly body is, rather than *what* it is, but within the present generation a new branch of astronomy has arisen, which studies the heavenly bodies for what they are in themselves and in relation to ourselves. Its study of the sun, for instance, beginning with its external features, led to the inquiry as to what it was made of, and then to the finding of the unexpected relations which it bore to the earth and to our daily lives on it, the conclusion being that in a physical sense it made us and recreates us, as it were, daily, and that the knowledge of the intimate ties which unite man with it brings results of a practical and important kind which a generation ago were hardly guessed at."

As the aims of this new astronomy are different from the old, so are its methods, in which it bears but an imperfect resemblance to those of the older or classic astronomy; and this diversity of method influences even the external structure. In place of an imposing edifice, crowned by a dome which shelters a great telescope, we are more likely to find a modest installation in which the telescope, though present, is not necessarily the important feature; in which there are no great meridian instruments, but instead a room sheltering spectroscopes, photographic objectives, and the like;

while in place of the equatorial and of the meridian instruments which are elsewhere used in the same way, night after night during perhaps a large part of the lifetime of the observer, the apparatus of the new astronomy is frequently modified, and, in an active observatory for solar research, will probably be found to be undergoing repeated change, the work being more or less of the nature of discovery, and each discovery leading probably to some alteration and improvement of the means by which the last was attained.

In the half century which has elapsed from the time when President Adams manifested so strong an interest in astronomy, and after the government had erected and provided for an observatory,— the United States Naval Observatory, at the capital, necessarily devoted to the pursuit of the old astronomy, since at that time there was none other,— the conception of another form of astronomy arose in the minds of men of science; and in 1861, when Kirchhoff and Bunsen published their researches on spectrum analysis, the "new astronomy" may be said to have been born.

It has been modified since in many directions, and as its public importance became recognized, it has at the hands of various European governments had special establishments consecrated to it. Thus, in France, in the Observatory of Meudon, near Paris, constant observations have been carried on upon the solar surface by Monsieur J. Janssen, by means of photographic processes, which have greatly surpassed in accuracy any preceding ones, while parallel researches have gone on there upon the nature of the absorption which produces the various lines of the spectrum, and other matters of interest in connection with solar studies.

The French government for two hundred years has had an observatory, within the city of Paris, devoted to the classical astronomy; and this new installation, at the Parc

de Meudon, overlooking the city, is a recognition both of the public importance of the work and of its distinct character from that prosecuted at the older establishments.

In Germany, the Prussian government, in addition to its observatory in the city of Berlin, for the old astronomy of precision, has erected and most liberally endowed an astrophysical observatory in the park in Potsdam, not very far from the capital. In Italy various establishments of the same character exist, and in other continental countries, and in England, there are several such observatories, due chiefly to private beneficence.

In the United States there are fewer; one of those most definitely devoted to the new class of investigation being that in the neighborhood of Pittsburg, which was maintained largely through the munificence of a private citizen, the late William Thaw, of that city.

Owing to the nature of the investigations carried on, the astrophysical observatory should be situated, as a rule, in the open country: not in the precincts of a city; for in many cases it is even more important than in an ordinary observatory that it should be remote from the tremor and disturbance of such a neighborhood.

When the writer—whose professional life has been largely given to these researches—was invited by Secretary Baird, of the Smithsonian Institution, to come to Washington, it was with the understanding that the government should be asked for, and might be expected to furnish, the means and the site for such an observatory; but the death of Mr. Baird prevented the matter having the aid of his weighty recommendation before Congress.[1]

[1] Concerning this it is remarked in the Report of the Secretary of the Institution for the year 1888:

"Natural science falls into two great divisions, the biological and the physical, and since it has been the case that of late years the first of these has been almost exclusively encouraged by the Smithsonian, it was the

When the writer accepted the position as Secretary of this Institution, in November, 1887, nothing had been done; but Doctor Jerome H. Kidder, a friend of the Institution and of the proposed observatory, had designed to interest wealthy private citizens of Washington in the plan, and to obtain from this source a fund which would be put at the disposal of the Smithsonian Institution for this purpose.[1]

The lamented death of Doctor Kidder put an end to this plan also, but through the generosity of Doctor Alexander

desire of the late Secretary, Professor Baird, to do something to restore the balance, and with this end in view he had made preparations to secure an astrophysical observatory and laboratory, and though these preparations were interrupted by his death, it is understood that through his action some friends of the Institution have already offered to give the means for the erection of the modest structure needed for the accommodation of such a special observatory. The site would necessarily be suburban, on account of the especial need of seclusion and the absence of tremor in the soil, such as is felt in the neighborhood of the streets of a city.

"No steps have yet been taken to secure a site, but in view of the promise of means for the building, and the fact that the construction of the necessary apparatus will occupy a long time, I have ordered such of the essential pieces as are not likely to be ready, even under these conditions, till the building is prepared to receive it." — Smithsonian Report, 1888, page 19.

[1] This is referred to in the Report of the Secretary for the year ending June 30, 1889, (page 7) as follows:

"In my last Report I spoke of the preparations made by the late Secretary for securing an astrophysical observatory and laboratory of research, and I mentioned that through his action some friends of the Institution had already offered to give the means for the erection of the simple structure needed for the accommodation of such a special observatory. I added that the site would necessarily be suburban on account of the special need of seclusion and the absence of tremor in the soil.

"I have elsewhere referred to the collections of the Institution in connection with the purchase by Congress of a zoölogical park, which it would appear to have been the first intent of Congress to place under the care of the Regents. It had been my hope in that case to place this observatory somewhere in the park, but in view of the long delay which has already arisen, and of the indefinite further delay which may occur, I have thought it better to put a wooden structure of the simplest and most temporary character in grounds immediately south of the Institution, although this site is quite unsuitable for a permanent building. Such a shelter will probably be erected before the coming winter, and will, while serving as a store-house for the apparatus, enable observations to be commenced.

"The promotion of original research has always in the history of the Institution been regarded as one of its most important functions, and the proper object of the personal attention of the Secretary; and I shall be very glad to do something in this direction on the most modest scale, rather than incur the chance of indefinite further delay."

And also in the Secretary's Report ending June 30, 1890 (page 10):

"I take pleasure in reporting that the Institution has been able to do rather more for the encouragement of original research than it has done for several years past.

"Referring to my two previous Reports in regard to the project of Professor Baird for securing an astrophysical observatory and laboratory, I am able to say that this object has assumed definite shape in the construction of the temporary shed which has just

Graham Bell, a sum of $5000 was at this time put at the disposal of the Secretary, for scientific researches, and Doctor Kidder had given a legacy of the same amount, which was by his wish to be devoted to advancing the interests of the new observatory.

Under these circumstances, the writer, in 1890, made a request to Congress for the assignment of a site, removed from the tremor of the city, on which it was proposed to erect a building of such an extremely modest character as could be put up for the sum in question, to be supplied with instruments, in part at least, by the Institution, and to be main-

been mentioned. In this shed there have been built, as the most expensive part of the structure, a number of brick piers required for the firm support of the delicate apparatus employed.

"The principal instrument consists of a siderostat constructed by Sir Howard Grubb, of Dublin, Ireland, for the Smithsonian Institution, to meet my special requirements. This arrived in March, 1890, and has been mounted and put approximately into position for use. Another important and novel instrument, a spectro-bolometer, was made under my directions to meet new and unusual demands, and has also been received and put in place. A third piece of apparatus, a special galvanometer, also designed for the particular class of work in view, has been received; and the only considerable instrument now required to complete the outfit is a resistance box, which has been ordered and is expected from London before the end of the calendar year.

"The siderostat is probably the largest and most powerful instrument of its kind ever constructed. The spectro-bolometer is the largest instrument of its kind, and with this improved apparatus it is hoped that interesting investigations begun several years ago will be continued.

"Supplementary to these there are a few pieces of apparatus, the personal property of the Secretary, so that at the close of the year it might be said that the Institution was in possession of the nucleus of a modern astrophysical laboratory. With this apparatus temporarily mounted, researches have already begun, and one of a scientific and economic character, upon 'The Cheapest Form of Light,' has been the subject of a communication to the National Academy of Sciences. This work is mentioned as indicating my intention to give greater place to one of the chief objects of the Institution,—the direct addition to knowledge by original research,—which, at least as regards the physical sciences, has received comparatively little attention since the time of Professor Henry.

"The prospects of renewed contributions to physical science by the Institution in the field of original research are happily now better than for many years past. The late Doctor Jerome H. Kidder, formerly an officer of the United States Navy, and later attached to the United States Fish Commission and to the Smithsonian Institution, had bequeathed to the Institution, in a will made several years ago, the sum of $10,000, to be employed for biological researches. Doctor Kidder, having become especially interested in the proposed astrophysical observatory, had the intention of transferring this bequest, or at least a portion of it, to such an end, and he even ordered that a codicil giving $5000 to the Institution for an astrophysical observatory should be added to his will, but he was stricken with so sudden an illness that he was unable to sign it. In view of these circumstances and after careful deliberation upon the matter, the Regents decided to accept as finally and decisively indicative of the wishes of the testator the provisions of this

tained by an appropriation from Congress. In anticipation of this, one or two of the principal instruments which would take long in construction were ordered in advance of the erection of the building which was to shelter them.

Owing to difficulties which it is not necessary to rehearse, the granting of a site, which it had been first proposed to occupy within the extended grounds of the new park, was deferred, and the following appropriation was made by Congress in the Sundry Civil Act of March 3, 1891.[1] It is proper to record that it was largely through the interest of Mr. Joseph G. Cannon, Chairman of the Committee of Appropri-

codicil bequeathing $5000 for the purpose of an astrophysical observatory, and this sum was therefore paid by Doctor Kidder's executor to the Institution.

"A further sum of $5000 was likewise generously presented by Doctor Alexander Graham Bell to the writer individually for the prosecution of the researches in astrophysics, to which he has devoted much of his life, but it has seemed proper to him, under the circumstances, that this sum should be placed to the credit of the Smithsonian Institution upon the same footing as the Kidder bequest, and with the consent of the donor it has been so transferred. I am, therefore, desirous of here expressing my own personal as well as my official obligation to Doctor Bell for this gift for the increase of knowledge.

"The initial step for the establishment of an astrophysical observatory under the national government thus having been taken by private individuals, it is hoped that Congress will see fit to place it upon a firm footing, and to make a small annual provision for its maintenance. And it seems proper to mention that the field of research to which such a department of the Institution would be devoted, has been considered of sufficient importance by the legislators of leading foreign nations to justify the erection of costly special observatories and to provide for their maintenance with a staff of astronomers and physicists of wide reputation.

"The class of work here specially referred to does not ordinarily involve the use of the telescope, and is quite distinct from that carried on at any observatory in this country. It would in no way conflict with the work of the present United States Naval Observatory, being in a field of work that the latter has never entered.

"Briefly stated, the work for which the older government observatories at Greenwich, Paris, Berlin, and Washington were founded, and in which they are for the most part now engaged, is the determination of relative positions of heavenly bodies, and of our own place with reference to them. Within the past twenty years all these governments but our own have established astrophysical observatories, as they are called, that are engaged in the study of the constitution of the heavenly bodies as distinguished from their positions; in determining, for example, not so much the position of the sun in the sky as the relation that it bears to the earth and to our own daily wants; how it affects terrestrial climate; and how it may best be studied for the purposes of the meteorologist, and so on; and it is an observatory of the latter kind that the donors just mentioned appear to have had prominently in view, and which it is proposed to conduct (though on an extremely modest scale) under the auspices of the Institution."

[1] Astrophysical Observatory, Smithsonian Institution, 1892. For maintenance of Astrophysical Observatory, under the direction of the Smithsonian Institution, including salaries of assistants and the purchase of additional apparatus, ten thousand dollars.

ations, and through that of Mr. J. D. Sayers, a subsequent chairman, that the appropriation was made. It was given with the understanding that this modest sum annually would suffice for some years for the maintenance of the observatory and for the provision of its apparatus, and this was the more feasible as no expenditure would be involved for its management and direction, which it was intended to leave in the hands of the Secretary, whose services would be given without cost to the government.

The Smithsonian Institution has the title to a park of about twenty acres of land, forming a portion of the larger area commonly known as "The Smithsonian Park," and in this narrow area, in the portion immediately south of the principal buildings of the Institution, surrounded by streets and traffic; in this (from a scientific point of view) most unfit site there was erected in 1890,[1] at the cost of the Institution,—not of

[1] "A temporary wooden building of the simplest possible construction has been erected in the Smithsonian grounds just south of the main building, having been begun on the 18th of November, 1889, and finished about the 1st of March, 1890. This building is not to be regarded as an entirely suitable or permanent housing for the instruments. Its location, close to traveled streets, is unsuited for refined physical investigation, but the preliminary adjustment of the instruments and certain classes of work can be effectively and conveniently carried on here.

"The principal instrument is a specially constructed siderostat by Sir Howard Grubb, of Dublin, Ireland. This instrument is in position. A spectro-bolometer, the outcome of many years' experience, has been made, under my personal direction, by William Grunow & Son, of New York, and has been received and mounted. A galvanometer, designed for the particular class of work in view, has been received, and was the last of the principal pieces of apparatus (provided for from the Smithsonian fund) to be put in place. The outfit is now in the main complete.

"This country has no observatory devoted exclusively to astrophysical research, though England, France, and Germany have maintained for a number of years at a considerable expense observatories for the study of the physical condition of celestial bodies. I therefore indulged the hope that, in presenting the matter to Congress, as previously reported, a request for a small annual appropriation for the maintenance of the observatory thus founded and equipped might meet with favorable consideration. I may say that the amount asked for ($10,000 for annual maintenance) has been appropriated, and will be available during the coming fiscal year.

"In adjusting and determining the constants of the instruments, a work involving considerable labor, I have had the valuable assistance of Professor C. C. Hutchins, of Bowdoin College, during a portion of the summer vacation. No permanent appointments of the assistants who will be required to carry on the investigations contemplated will be made until after the appropriation shall have become available." — Smithsonian Report, 1891, page 7.

Congress,—a one-story building, or rather shed, whose object was to furnish an immediate shelter for the instruments already ordered, and to enable some work to be done under the appropriation while a more suitable site and building were being provided. This site has not yet, after a lapse of over six years, been obtained, and the investigations which are to be described have been carried on under all the disadvantages of such an entirely inadequate installation.

It will be seen in the subsequent description of this work that above any other department, even, of astronomical research, it demands entire quiet and absence of tremor in the surroundings, and that it has been necessary to give so long a time to certain researches is due to the difficulties inherent in the site rather than in the methods of observation.

I MAY preface a brief account of the work of this new observatory by repeating a portion of what has been already said, in laying before the committees of appropriations of the Senate and House, the reasons which should induce government aid:

"The general object of astronomy, the oldest of the sciences, was, until a very late period, to study the places and motions of the heavenly bodies, with little special reference to the wants of man in his daily life, other than in the application of the study to the purposes of navigation.

"Within the past generation, and almost coincidentally with the discovery of the spectroscope, a new branch of astronomy has arisen, which is sometimes called astrophysics, and whose purpose is distinctly different from that of finding the places of the stars, or the moon, or the sun, which is the principal end in view at such an observatory as that, for instance, at Greenwich.

"The distinct object of astrophysics is, in the case of the sun, for example, not to mark its exact place in the sky, but to find out how it affects the earth and the wants of man on

it; how its heat is distributed, and how it, in fact, affects not only the seasons and the farmer's crops, but the whole system of living things on the earth, for it has lately been proven that in a physical sense it, and almost it alone, literally first creates and then modifies them in almost every possible way.

"We have, however, arrived at a knowledge that it does so, without yet knowing in most cases how it does so, and we are sure of the great importance of this last acquisition, while still largely in ignorance how to obtain it. We are, for example, sure that the latter knowledge would form among other things a scientific basis for meteorology and enable us to predict the years of good or bad harvests, so far as these depend on natural causes, independent of man, and yet we are still very far from being able to make such a prediction, and we cannot do so till we have learned more by such studies as those in question.

"Knowledge of the nature of the certain, but still imperfectly understood, dependence of terrestrial events on solar causes is, then, of the greatest practical consequence, and it is with these large aims of ultimate utility in view, as well as for the abstract interest of scientific investigation, that the government is asked to recognize such researches as of national importance; for it is to such a knowledge of causes with such practical consequences that this class of investigation aims and tends.

"Astrophysics by no means confines its investigation to the sun, though that is the most important subject of its study and one which has been undertaken by nearly every leading government of the civilized world but the United States. France has a great astrophysical observatory in Meudon, and Germany one on an equal scale in Potsdam, while England, Italy, and other countries have also, at the national expense, maintained for many years institutions for the prosecution of astrophysical science.

"It has been observed that this recent science itself was almost coeval with the discovery of the spectroscope, and that instrument has everywhere been largely employed in most of its work. Of the heat which the sun sends, however, and

which, in its terrestrial manifestations, is the principal object of our study, it has long been well known that the spectroscope could recognize only about one-quarter; three-quarters of all this solar heat being in a form which the ordinary spectroscope cannot see nor analyze, lying as it does in the almost unknown 'infra-red' end of the spectrum, where neither the eye nor the photograph can examine it. It has been known for many years that it was there, and we have had a rough idea of its amount, with an almost total incapacity to exhibit it in detail. Our imperfect knowledge of this region is at present represented by a few inadequate types of parts of it given in drawings made by hand, where the attempts to depict it at all are even to-day more crude than the very earliest charts of the visible spectrum made in the infancy of spectroscopic science.

"One of the first pieces of work which this observatory has undertaken is to explore and describe what may be properly called 'this great unknown region,' by a method which the writer has recently been able to bring to such a degree of success as to give good grounds for its continued prosecution and for the hope that a complete map of this whole region will shortly be produced by an automatic, and therefore trustworthy, process, showing the lines corresponding to the so-called Fraunhofer lines in the upper spectrum."

It is now well understood that nearly every movement which goes on within the confines of this planet, not only from changes of the seasons or of rain, or the movement of wind, or storm, but every manifestation of life from that of the lowest vegetable form, up through animal existence, to that of man, including all his works and industries, comes from the sun, so that man himself and all his works are, in a physical sense, strictly its product.

It is known in some cases to what these effects are traced, in the greater number we are still ignorant, but in all cases we know that a something we call "energy" comes across the

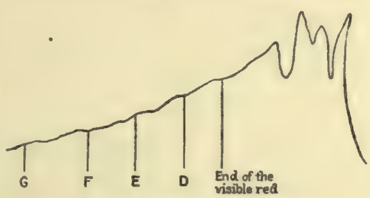
void of space from the sun to the earth in its rays, and falling upon us affects our senses in various ways.

When it falls upon our bodies it produces a sensation of warmth; when it falls upon our eyes it produces a sensation that we call "light"; when it falls upon our skin it produces also an effect different from either; for instance, it tans the cheek, by what we call chemical action, but these three different effects are caused by the same thing — solar energy, which differs in its manifestations according to the body on which it falls, but is one and the same always in its essence. When it falls upon the ocean it draws the water up into the sky to drop subsequently to the earth as rain; when it falls upon the land, it rears everything from the blade of grass to the tree; and so through all animate and a large part of inanimate nature we find everything that affects man and his interests on the earth to come to us in this sunbeam, whose study gradually leads to conclusions of not merely interesting but of an eminently practical character.

Sir Isaac Newton, letting these rays pass through a prism, discriminated between them, pointing out that they were composed of different colors, but he did not know that there was anything in them beyond what the eye could see. Nearly one hundred years later, in the first year of the present century, it occurred to Sir William Herschel to move a thermometer in the spectrum formed by a prism, and notice the heat in the different rays. He found little heat in the blue, more in the green, and more still in the red, where to the eye the spectrum appears to end. Carrying the thermometer still further, that is, entirely outside and beyond the visible spectrum at its red end, he found that the instrument rose still more, showing that there was something there invisible to the eye. It was recognized later that the heat in this invisible region was greater than all the heat in the region that

could be seen; but beyond this little was known, except the fact that this heat was of different kinds, and possessed of different properties, in the same way that light is possessed of different colors; there was no considerable investigation of the matter, from the lack of any thermometer delicate enough to appreciate the heat in very small portions, and capable of being placed with such precision as to discriminate the positions of these portions one from another.

Since the beginning of this century, it had been known that there had been made visible to the eye in the Newtonian spectrum certain sharply defined black lines called, from their discoverer, "Fraunhofer lines," and which we now know are caused by selective absorption in the atmospheres of the sun and of the earth jointly. Some of these are due to our atmosphere alone, and come and go with different states of the weather, affording a direct means of predicting the approach of rain. All of them are of interest in other ways than to the meteorologist, though all are interesting to him also.



LAMANSKY'S CURVE.

Now, if we take a base line, and at certain intervals, set off upon it perpendicularly lines proportional to the height of the thermometer in the corresponding parts of the spectrum, we obtain some such curve as is shown in the figure, where the portion on the right indicates what is invisible, and shows three interruptions, discovered by Lamansky in 1871,[1] and which as indicating nearly all that was known before the writer commenced his work may be compared with the curve given later. The invisible portion of the spectrum contains a great deal more energy than all the

[1] Lamansky M. S. "On the Heat-Spectrum of the Sun and the Lime-light." *London, Edinburgh, and Dublin Philosophical Magazine*, Volume LXIII, 1872, page 282.

rest that is visible. The actions, then, to which nearly all the changes on earth are due, go on principally in this invisible region; but, with the exception of some investigations by Draper and Becquerel in the part just below the visible red, this was all that was known in the matter twenty years ago; for since these rays cannot be seen, and cannot be made evident by ordinary photography, there remains no way of investigating this most important region, except by means of some instrument which, like the thermometer or the thermopile, will register the heat. For lack, then, of a more sensitive instrument than science possessed, in this way, very little had been done until the year 1881, in which the writer invented a more delicate method of measuring heat, by means of an instrument which he called the "bolometer." This consists essentially of a metallic tape, usually about a third of an inch long, but narrower and far thinner than a human hair, through which an electric current is kept constantly passing. It is found that the slightest change in the heat which falls on this tape will affect a distant galvanometer connected with it, so that as the effects of vision are no way concerned, but only of heat, this may be compared, figuratively, to an eye which sees in the dark. Moreover, as this thread can also be pointed with extreme precision, as in the case of a vertical thread of an ordinary transit instrument, the greater sensitiveness is accompanied by a corresponding accuracy of measurement.

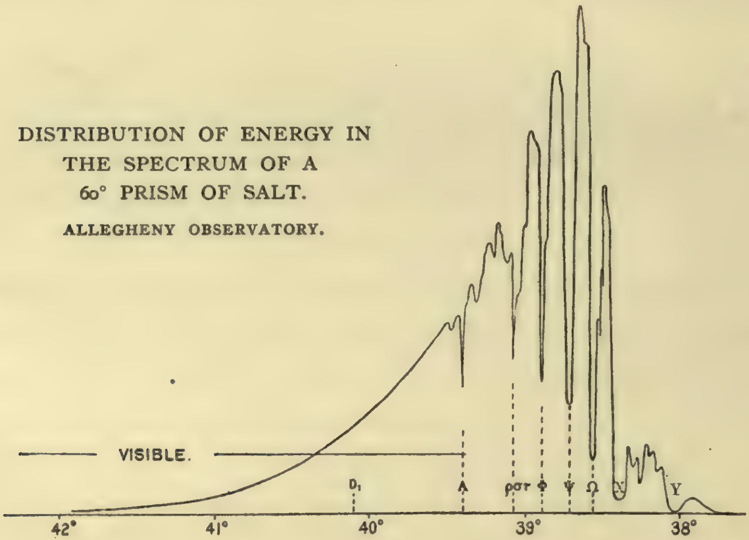
This instrument was, at that time, able to indicate a change of temperature of one one-hundred-thousandth of a degree, and it had the incidental advantage that it could be pointed so as to tell, within a fraction of a minute of an arc, in what part of the spectrum the change to which it was sensitive was found.

A full description of the bolometer must be sought else-

where; but, in further explanation, it may be said that the electric current always passing flows less freely when the minutest degree of heat falls upon the strip, and more freely when this is made in the least colder, so that the galvanometer needle swings in the first case to the right, and in the second to the left; and this, at present, may be arranged to record changes of temperature as small as one millionth of a degree. When this minute strip, or tape, is moved through the invisible spectrum, the tape being parallel to the Fraunhofer lines, since what is black to the eye is cold to it, its contact with one of them produces cold, which increases the flow of electricity, and the galvanometer needle moves as described. When it passes into a warmer region, the needle moves in the opposite direction; and in each case the amount by which the needle moves is proportional to the degree of heat or cold in question, so that the final result is the same as if a thermometer could be constructed much finer than a human hair, from which all of these indications could be read on such an extended scale that the millionth part of a degree was visible, this thermometer being moved through the spectrum, and falling or rising, according as it meets one of these dark and cold lines or goes into a warmer region. This rise or fall indicates, then, the presence of such a line, whether the eye can see it or not, and when we pass out of the visible into the invisible region, this method remains trustworthy where the eye and photography both fail us.

When the instrument was first used, at least two observers were required, one to note the reading of the circle which fixed the place of the bolometer in the spectrum, and another who sat at the galvanometer and noted through how many divisions of the scale the needle swung, owing to the electric disturbances, the whole process being comparable to a groping in the dark, involving going over and over the work again

and again, month after month and year after year, with almost interminable repetition, so that a galvanometer had, in fact, to be read over a thousand times to obtain with sufficient accuracy the position and amount of a deflection of the energy curve in any single part of the invisible region. It took nearly two years to fix the position of twenty lines by this process, with the degree of accuracy then aimed at.



DISTRIBUTION OF ENERGY IN THE SPECTRUM OF A 60° PRISM OF SALT.

ALLEGHENY OBSERVATORY.

The annexed figure shows the amount of heat in different portions of the spectrum shown by the inflections of the curve as obtained by this early process; but since it took two years to fix the position of twenty lines by this means, it would take a hundred years to fix the position of a thousand lines, supposing they existed; and it became evident that, if the bolometer continued to be the only means available, new methods of using it must be devised.

Accordingly, when this work was commenced at the Smithsonian Observatory, a plan which had been under study by the writer for more than ten years was introduced, by means of which the work could be carried on not only with far

greater rapidity, but with greater certainty, and by an automatic process. The idea in its original simplicity is very easily understood.

In the old process, just described, the deflection of a spot of light upon a scale was read by one observer, while another simultaneously read the position in the spectrum of the cold band, or line, which caused the thermo-electric disturbance.

Now, in imagination, let us take away both the observer at the circle and the one at the galvanometer, and in the latter case remove the scale also, and put in its stead a photographically sensitive plate. As the needle swings to the right or left the spot of light will trace upon the plate a black horizontal line, whose length will show how far the needle moves and how great the heat is which originated the impulse. If this be all, when under an impulse originated by the movement of the spectrum over the bolometer thread the needle swings a second time, it will go over the same place; but if the plate have given it by clockwork a uniform vertical movement proportional to the horizontal movement of the spectrum, the combination of the two motions of the needle and the plate will write upon the latter a sinuous curve which will be, in theory at least, the same as the curve formerly deducible, only with much pains, from thousands of galvanometer readings.

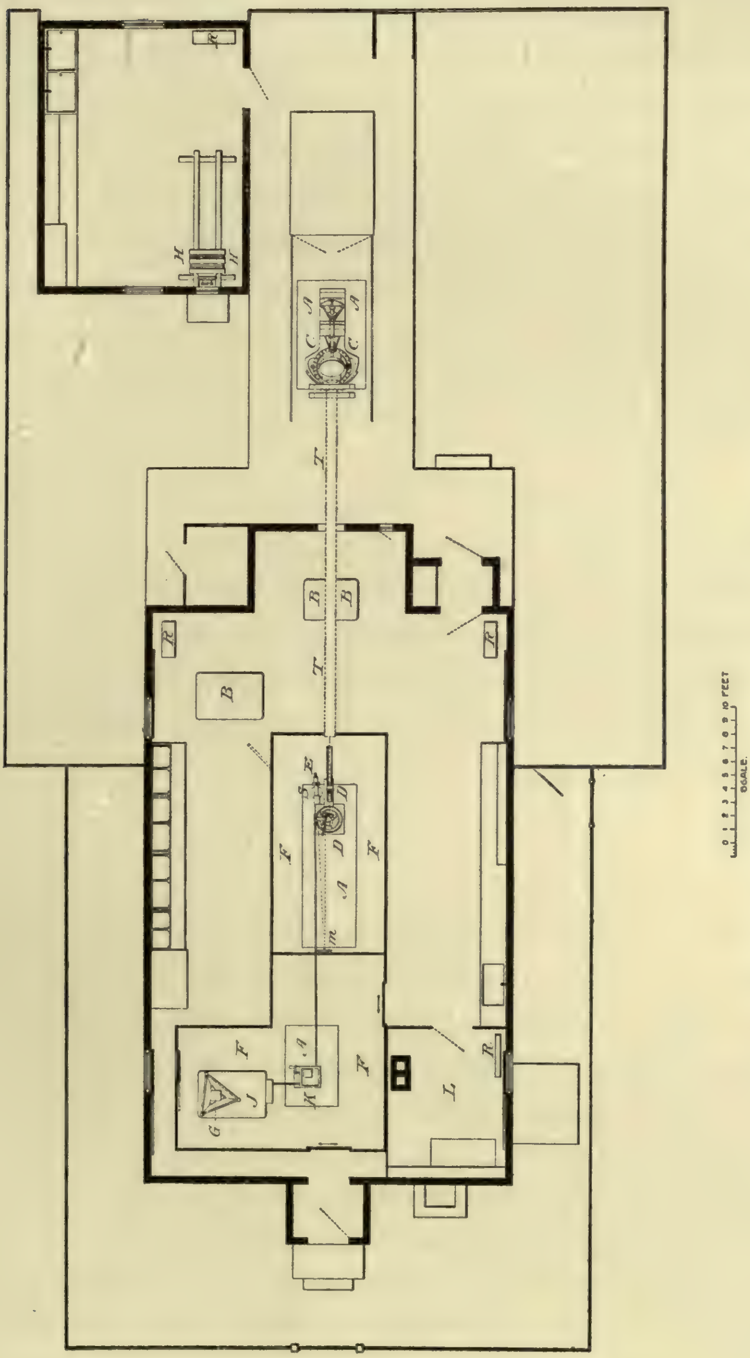
If we suppose that the movements of the invisible spectrum, as well as of the plate, are controlled by the same clockwork, so that this spectrum is caused to move uniformly over the bolometer thread, and that these movements are, by accurate mechanism, rendered absolutely synchronous with those of the moving plate, it is clear that we shall be able to readily deduce from the photographic curve traced on the latter not merely the amount of the heat, but each particular position in the spectrum of the thread of the bolometer,

which alone can correspond with any given inflection of the curve.

The theory is simple, but the practice is extremely difficult, and it has, in fact, consumed nearly five years of continuous labor to produce the results which are obtained by the present apparatus, which works in the following manner:

A beam from the mirror of the siderostat is conveyed through the slit of a telescope having a rock-salt objective of about ten meters focal length to the prism, which is mounted on the massive spectro-bolometer, the novel feature lying in the mechanical connection of the large circle carrying the prism with a distant photographic plate, susceptible of vertical motion, and taking the place of the scale formerly in front of the remote galvanometer, both circle and plate being now moved by the same clockwork, through a continuous train of shafting, which works with such steadiness and precision as to make the two movements entirely synchronous.

To understand this better, let us suppose that the very slowly moving circle carrying the prism moves the spectrum through one minute of arc in one minute of time, across the vertical bolometer thread. To the observer watching the spectrum the motion is as slow as that of the hour-hand on the dial, but it is continuous and uniform, and the same mechanism which causes this motion of the spectrum of one minute of arc in one minute of time causes the photographic plate to move vertically, before the galvanometer mirror, at any given rate,—for instance, at the rate of one centimeter of space in one minute of time. It follows that during every second of this minute a portion of the spectrum represented by one second of arc will have glided before the bolometer thread, and that during this same second the photographic plate will have been lifted automatically through one sixtieth of a centimeter in space; the essential thing being that the plate shall



GROUND PLAN OF THE ASTROPHYSICAL OBSERVATORY.

show, on simple inspection, not only the inflection of the energy curve there written down, but the exact relative position in the distant spectrum which the bolometer thread occupied at the moment it caused the disturbance. By suitably changing the wheels in the clockwork we may cause the spectrum to move fast or slow, in the former case giving only its principal inflections, in the latter case giving a great deal more of detail, but with liabilities to error, which will be spoken of later.

The building shown in the annexed sketch plan, which was erected in 1890 at the cost of the Institution, has been slightly modified from its original form to meet the wants of this process as they have been developed by experiment, and it is only lately that the small photographic room shown at the right has been added. The observatory's latitude and longitude as given by the United States Coast and Geodetic Survey is $38° 53' 17''.3$ and $5^h 08^m 06^s .24$ respectively.

The building is essentially a room arranged so that it can be closed to all light by means of sliding shutters before the windows, and by a sliding shutter under the skylight in the roof, and containing an inner chamber F F which can be kept at a constant temperature. In the front is a small room L containing books and writing materials, below which is a cellar in which are stored the batteries and a furnace, the latter being no longer used, having been replaced by steam radiators R, operated from another building. Around the walls are cases containing those pieces of apparatus which are not in constant use, and, with the exception of the small cellar, the floor joists are almost in contact with the soil, but piers for the instruments rise to the level of the floor at A, 76 centimeters above the floor at B, and 40 centimeters above the floor at J. When the shutters are closed the only light which enters comes from the siderostat at C, which

sends a horizontal beam from north to south along the meridian at a height of 110 centimeters from the floor, through the tube T.

The principal piece of apparatus, the spectro-bolometer, is shown at D. This instrument, made by W. Grunow & Son, is a development of that already devised by the writer and figured by him in the "American Journal of Science."[1] Its object is to enable researches to be made on that invisible portion of the solar radiation below the red in which it is now known that a greater part of all the solar energy lies, in a region whose details have been, up to the present researches, comparatively unknown.

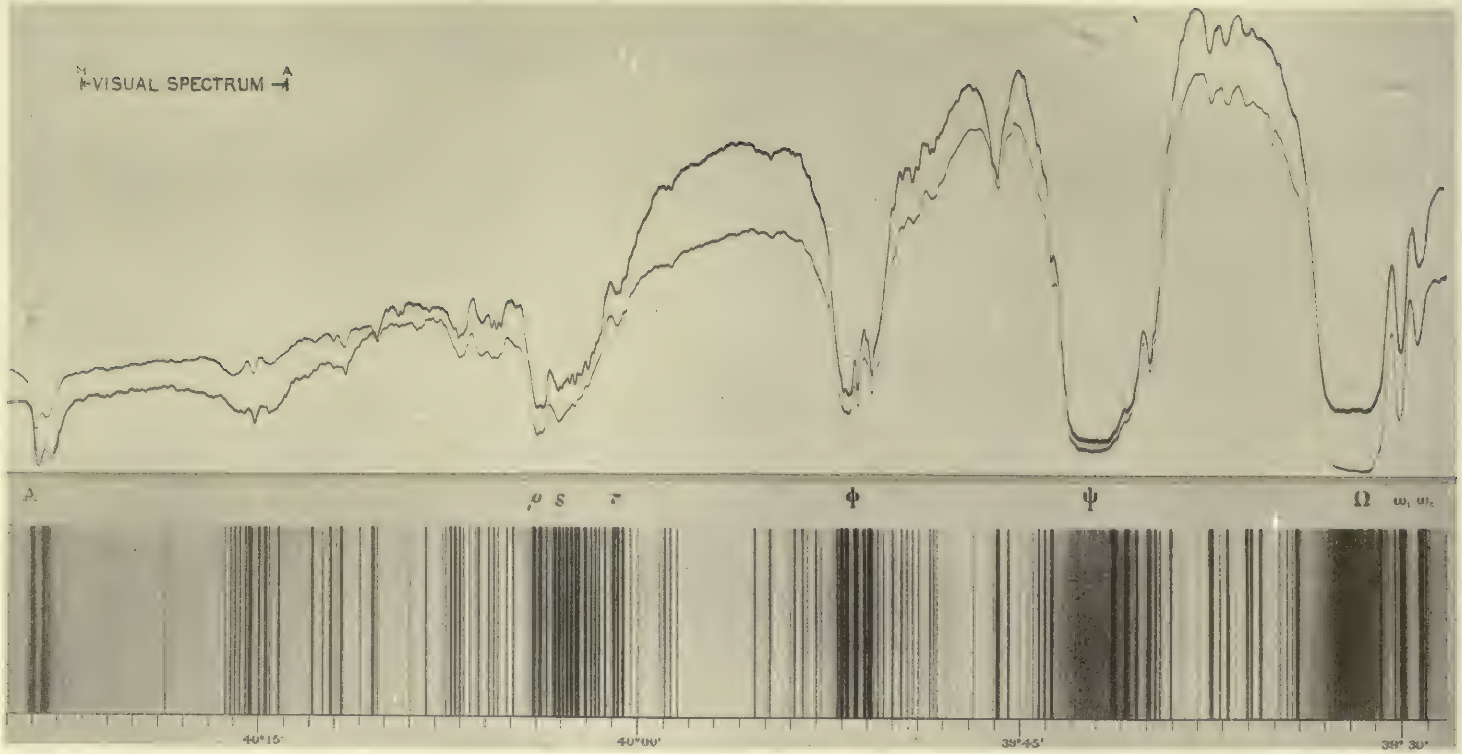
This instrument consists of an azimuth circle of 52 centimeters diameter, reading by verniers to five seconds of arc. Over the center of the azimuth circle is a prism, ordinarily of rock-salt, a material pervious to the rays in question, which do not freely pass through glass. This prism is fixed to a mirror parallel to its rear surface, and it turns with it when the circle is turned. A horizontal ray from the siderostat, which falls upon the prism, passes through it at an angle of minimum deviation, falls upon the plane mirror, and is by that reflected to a distant concave mirror, *m*, by which an image of the spectrum is formed at S. In the actual case, the visible part of the solar spectrum is about nine inches in length and one high, and filled with Fraunhofer lines, which are visible to the naked eye when projected upon a screen. The rays fall upon the strip of the bolometer at E.

If, now, the circle be moved by the clockwork K, and with it the prism and its attached plane mirror, the spectrum is put in motion relatively to the bolometer strip, so that this is virtually carried through the spectrum, its exact position in it being at all times determined by reference to the circle.

[1] "The Selective Absorption of Solar Energy," Volume xxv, page 169, March 1883, plate 2.

As the strip of the bolometer passes through a dark line, its temperature falls, less current passes through the cable connecting it with the distant galvanometer, shown at G, and the needle of the latter instrument is deflected, showing how great the radiant heat of the spectrum was at the precise position in question. In the accompanying illustration are shown two such curves obtained on different days, quite independently of each other, by two successive movements such as have been described through the whole spectrum. They represent nearly two hundred lines, which are otherwise shown in the plate in the usual form as a line spectrum. The general coincidence of the two curves one with another affords the most convincing proof that could be desired of the accuracy of the process, which thus obtains in a few hours data which could hardly be obtained by a life-time of assiduous labor with the old one. But this new method is so sensitive that it can record more minute inflections than are here set down, these inflections being intentionally slurred over, as here given.

When, however, we proceed with the aim of developing all the minute deflections that are caused by the changes in the atmosphere of the sun and the earth, we are confronted with the difficulty common to delicate physical measurements of every kind, that, owing to the sensitiveness of our apparatus, it will register deflections due to causes which we are not concerned with, and do not want to record. For instance, if a wagon be passing in a distant street the jar communicated to the ground, although quite imperceptible to all ordinary sense, will be registered by the galvanometer, forming a minute inflection of the curve, which might be confounded with those produced by the action of the sun itself, the distant sun and the wagon in the next street registering their action in the same place and in the same manner.


VISUAL SPECTRUM
ρ S τ
Φ
Ψ
Ω ω₁ ω₂
40°15'
40°00'
39°45'
39° 30'

There are many other causes of local disturbance, but it should be understood that they are too slight to distort the record, when we are only taking the main features of the solar curve, as is shown in the example just given. But it is when the minuter details of the solar and terrestrial observations are sought that these local disturbances, which are of the same order of magnitude, become especially troublesome. When, therefore, we proceed to make a fuller map of the irregularities of the invisible spectrum than shown above, we are compelled to study the causes of these accidental deflections, and to try to eliminate them, and this necessity has greatly delayed the work, a full account of which will shortly be published.

The professional reader must be referred to professional papers for an account of the means of overcoming these difficulties, but that the general reader may conceive of the results achieved, it is remarked that each inflection of the curve is convertible into a line by a nearly automatic optical process, giving linear spectra, and while the measurements of precision are made upon the original curves, these linear spectra are united by a process of composite photography for the purpose of illustration. That presented on the accompanying plate is obtained by another method.

With it is given on the scale of mean dispersion the length of the spectrum as known to Sir Isaac Newton "(H—A)" to show what the extent of the increase in our knowledge has been. Describing it otherwise upon the scale of the normal spectrum, it may be stated that if the length of the spectrum as observed by Newton be unity, its length as here given would be represented by a little over twelve, and very nearly all of this addition has been made by the application of the processes which have been described.

A comparison of the three superposed curves with the

vignette already given from Lamansky's drawing will show in another way the progress which has been made by bolometric research.

I have described here but one research, though that is not the only one prosecuted at the observatory. Among others one of more general interest is that on the "Cheapest Form of Light," carried on by the joint use of the bolometer and photographic processes, of which an account will be found in the "American Journal of Science."[1] The principal conclusion of the research just named is that processes exist by which light can be produced without the present waste of energy in producing invisible heat along with it — a conclusion of much practical importance.

Other and subordinate researches will be described elsewhere; of the principal one here spoken of it is proper to repeat that the difficulties have been enormously increased by the unsuitability of the site, and that it is to be earnestly hoped that the Institution may be enabled later to provide a more fitting one.

1 Volume XL, page 97, August, 1890.

THE NATIONAL ZOÖLOGICAL PARK

By Frank Baker

INTEREST in living animals is a characteristic of both savage and civilized man. Doubtless this was at first a mere curiosity to know more of the creatures he pursued in the chase or against whose attacks he had to guard, but later it rose to that desire to understand the phenomena of life in general, to obtain some insight into the mysteries of being, which is at the root of all scientific zoölogical studies.

Royal preserves and menageries are as old as the civilizations of Assyria and Egypt, and it was from the East, by means of the Roman conquerors, that the first collections of animals were brought to Europe. The displays of the Roman triumphs and the conflicts of famishing beasts in the arena were but little calculated to advance the interests of zoölogy, but it is from these that we trace the genesis of the zoölogical collections of to-day. Exhibitions of animals for the purpose of impressing the populace with the wealth or power of the ruling sovereign were common during the Middle Ages. The Emperor Frederick II had at his Sicilian court a notable collection, from which he sent to Henry III of England three leopards, in compliment to the three animals of that species

which appeared in that monarch's coat-of-arms. These animals, with an elephant sent not long after by Louis IX of France, formed the nucleus of the famous Tower Menagerie, that was kept up until 1834, when it was merged with the Zoölogical Garden now in Regent's Park in London.

The well-known collection of exotic animals in the Jardin des Plantes in Paris had a similar origin, being derived from the royal menagerie maintained with different degrees of interest by various kings, and finally, at the time of the French Revolution, turned over to the people.

The conditions prevalent in these royal collections were not as a rule favorable to the study of animals, and we consequently find that with few exceptions they aided the advancement of zoölogy but little. The animals were usually kept in small and badly ventilated cages with slight regard to their proper food or natural habits, and it is therefore not at all surprising that the mortality among them should have been very great. It was not until the care of such collections was intrusted to scientific zoölogists that any improvement was manifested.

The collections of Europe seem, however, to have been surpassed in extent, variety, and magnificence by those of the New World, where an equable climate, a rich fauna, and a natural fondness of the natives for animals appear to have combined to produce much better results. The accounts of the menageries of Montezuma and the Incas read like fairy tales. They were doubtless of great size and richness, but the conquerors of Mexico and Peru left nothing of these extraordinary collections.

In the United States the establishment of permanent collections of animals for public exhibition is comparatively recent. The menagerie in Central Park in New York was not contemplated by the original plan of that park, but grew

up from chance gifts made to the city authorities, from 1860 onward.

In Philadelphia a zoölogical society, composed of public-spirited citizens interested in natural history, succeeded in 1872 in raising sufficient funds to begin the construction of a zoölogical garden in a retired portion of Fairmount Park. This garden, though limited as to space, has always been conducted with reference to the advancement of science, and is now, probably, the most important collection in America. A zoölogical society in Cincinnati also succeeded in 1874 in securing a collection of animals for exhibition. It now has an excellent garden in a flourishing condition. Collections of living animals have been formed in San Francisco, Chicago, St. Louis, Atlanta, Buffalo, Detroit, Pittsburg, and other places. Some of these are controlled by the city authorities as an attractive feature of public parks, others kept by private parties for their own pleasure or profit in game preserves thousand of acres in extent.

The collection of animals for exhibition as museum specimens was early commenced by the Smithsonian Institution. This necessarily involved the accumulation of skins and skeletons and the employment of skilled taxidermists to study the natural forms of living animals in order that they might impart to the prepared specimens the grace and characteristics of life. A considerable number of living animals was obtained for this purpose annually, and as there were no adequate arrangements for keeping them, they were, after serving as studies for the modeler, either killed for their skins, or, if not desired as specimens, sent to the zoölogical garden in Philadelphia. During their temporary detention at the Institution such specimens attracted much notice from visitors. It early occurred to Mr. S. P. Langley, the present Secretary of the Smithsonian Institution, that it would be

easy to extend this method so as to secure a considerable collection of living animals.

The National Museum was fortunate in having upon its staff at that time Mr. William T. Hornaday, well known for his unusual skill as a taxidermist, and for his travels in Borneo and South America for the collection of specimens of natural history. As his interest in the matter was very great, a separate department of the National Museum, that of living animals, was created, and of this he was appointed curator. As a result of his energy and activity the museum possessed, at the close of the fiscal year 1887–'88, no fewer than two hundred and twenty living specimens.

At this time public interest was much excited by the almost total extinction of the American buffalo or bison, which once covered the country as far east as Virginia with herds of almost countless numbers, and which, retreating before civilization, had finally succumbed to the unchecked extravagance of avaricious hunters and the repeating rifle until there remained but a few herds, small in numbers and widely scattered. This is one of the most striking and appalling cases of the effect of the contact of man with animate nature, but many others were also noted which, though less in degree, showed all thoughtful people that most of the larger native animals indigenous to this continent were doomed to extinction unless active measures were taken to protect and preserve them. The great auk and the sea-cow of Steller are now to be seen only in museum cases, and rank in the popular mind with the dodo and the megatherium; the sea-elephant has nearly if not wholly disappeared, and the manatee is approaching extinction. The moose, the caribou, the antelope, the mountain sheep and goat, the fur seal, the sea otter, the Pacific walrus, and even the grizzly bear and panther, are rapidly disappearing, and in a few generations

may share the fate of the moa, the mammoth, and other animals once widely distributed but now extinct.

The loss to zoölogical science in the disappearance of these animals is, of course, very great, and from an economic point of view the matter is by no means to be disregarded. When we consider the enormous food value of the great herds of bison, that, with a little care, might have been preserved almost indefinitely upon those parts of the country fitted only for grazing, we realize how shameful and unwise the waste has been. The extirpation of the fur seal and sea otter deprives this country of some millions of dollars of annual revenue; the elk and deer if carefully protected would yield flesh and skins of considerable value; the wild pigeon and the prairie chicken, now nearly extinct, have had a definite market value of no small amount. When we notice with what care similar animals are preserved in European countries, and the prices that they readily command when brought to market, the reckless extravagance with which the vast animal resources of this continent have been wasted becomes apparent. It seemed to Secretary Langley that the Institution might do something to bring this matter clearly before the eyes of our legislators and of the public generally by exhibiting specimens of the most important animals likely to suffer extinction, placing them as nearly as possible in the conditions natural to them so that they might breed and thrive in captivity as in their native haunts. An enterprise of this kind could also assist in the general diffusion of zoological knowledge, especially if there were associated with these animals that it was desired to preserve from extermination such specimens belonging to the fauna of widely distant regions as might be useful for purposes of comparison or illustration. There would thus be combined the advantages of a park in which animals could be studied in nearly

their native condition and the attractions of the ordinary zoölogical garden.

It was believed that this project was entirely novel and that it marked some advance over any scheme for the maintenance of animals in captivity that had up to that time ever been proposed. The zoölogical gardens of European capitals are invariably situated in the midst of a numerous population, where spacious grounds cannot be spared for their maintenance. This greatly embarrasses their development and the result is that the animals therein exhibited rarely if ever appear in their natural conditions, and the old methods of crowding, a heritage from the royal menagerie, yet prevail to some extent. It is rarely possible to accommodate their captivity to their obvious needs.

The question of a possible site for such an enterprise was at once raised. Secretary Langley, with rare judgment, turned his attention to the picturesque valley of Rock Creek, a small affluent of the Potomac that empties at Georgetown. This little stream, ordinarily very quiet and peaceful, drains an area of about eighty square miles in the District of Columbia and Montgomery County, Maryland. The steepness of its watershed, which lies among the foothills of the Blue Ridge, is such that in a few hours, after a heavy and prolonged rain, the little brook may swell to a foaming torrent. This has caused an amount of erosion that seems quite out of proportion to the size of the stream, and it accordingly lies some two hundred feet below the level of the surrounding hills, in a valley varied greatly in its aspect according to the devious windings of the stream and the nature of the soil. It would be impossible to find in this latitude a situation more admirably adapted to the preservation of wild animals, combining as it does exposures of every variety, sunny slopes and cool hillsides, level meadows and rocky cliffs, affording

an abundance of excellent water, and sufficiently near the city to make it easily accessible.

Fortunately the land along this beautiful stream, being hilly and not immediately available for building purposes, had not shared the general advance of prices that had affected nearly all property in the vicinity of Washington. Upon a hasty survey of the region made by Mr. Hornaday, under the direction of the Secretary, it was found that a tract of one hundred acres or more could be procured for a sum that did not seem exorbitant.

It was not found difficult to interest public-spirited persons in an enterprise of this novel and peculiar character, which would not only afford an excellent opportunity for zoölogical study, but would also give to the public a beautiful pleasure ground, and preserve from devastation and the real-estate agent a delightful region greatly needed as a park by the inhabitants of Washington. Senator Beck, of Kentucky, and Senator Morrill, of Vermont, were among the first to warmly espouse the cause of the new park. The former introduced a bill on April 23, 1888, which provided for a commission, composed of the Secretary of the Interior, the President of the Board of Commissioners of the District of Columbia, and the Secretary of the Smithsonian Institution, which was to have power to select and obtain land, to lay it out as a National Zoölogical Park, and finally to turn the same over to the Regents of the Smithsonian Institution. This bill received the earnest support of Senator Morrill and many other gentlemen in both Houses of Congress. Attached as an amendment to the sundry civil appropriation bill, it failed before the conference committee appointed by the two Houses.

At the next session of Congress a measure of a similar character was introduced by Senator Edmunds as an amendment to the District of Columbia appropriation bill. With

this was associated an appropriation of $200,000 for the purchase of land for the desired site. It became a law upon March 2, 1889.

The commission constituted by this act made an exhaustive examination of all the land in the valley of Rock Creek available for a site, and finally selected about one hundred and sixty-six acres lying two miles from the Executive Mansion and not far distant from frequented public roads and street-car lines. Some difficulty was found in establishing the boundaries of some of the tracts, owing to the fact that many of the landmarks described in the earlier deeds had become obliterated by the lapse of time. This was, however, satisfactorily overcome at last, and the survey of the grounds was finally completed November 21, 1889. It was not until November 4, 1890, that possession was finally obtained of the entire site.

On April 30, 1890, an act was passed definitely placing the National Zoölogical Park under the direction of the Regents of the Smithsonian Institution, authorizing them to transfer to it any living animals in their charge, to hereafter make exchanges of specimens, and to administer the Park "for the advancement of science and the instruction and recreation of the people." Thus the National Zoölogical Park became an accomplished fact, and the work of developing it was begun with great enthusiasm.

The first care was, necessarily, the preparation of the site and the providing of means of access to it. The funds at the disposal of the Regents for all objects, including roads, walks, bridges, water-supply, sewerage, fencing, and buildings, were less than $100,000; and when it is remembered that the zoölogical collections of other cities are housed in buildings of modest proportions, it is true, but which have cost from $300,000 to $400,000, it will be seen that no very

great results were to be expected from such inadequate means. The preparation of grounds alone must necessarily be very expensive — the proper laying out, planting, and improving for park purposes being estimated by experienced authorities at from $3,000 to $5,000 an acre.

It was at once determined to procure the best possible professional advice for the general planning and laying out of the park, it being felt that the utmost care should be taken to preserve the extraordinary natural beauties of the region, and that none but a master could be expected to adapt to the needs of the project so charming a piece of picturesque rural landscape. Mr. Frederick Law Olmsted, whose reputation as a landscape architect is world-wide, was asked to give his advice, and visited the park on several occasions for that purpose. While it has not been possible, from want of funds, fully to carry out the plan outlined by him, it is hoped that no serious errors have been made, and that the leafy retreats of this lovely valley afford much the same pleasure to the tired citizen that they did when their beauty was known to few beyond the wandering naturalist and the solitary rambler.

It being impossible, with the resources at command, completely to develop the entire area of the park, it was found advisable to select a portion of the most available ground for immediate improvement, leaving the remainder in a state of nature. The area selected comprised about fifty acres situated in the most central part of the park, where previous clearings had already made some open fields and grazing land, and where the ground was sufficiently level to offer a variety of suitable building sites.

Considerable sums were necessarily expended in laying out roads, in protecting the banks of the stream, in forming ponds for aquatic animals, and in planting and otherwise

improving the grounds. There is at present a single main macadamized road extending through the park. Though this is by no means free from defects, as on the side next the city the approach is so steep as to be dangerous for heavily loaded vehicles, it has served the purpose of access. It is expected that additional roads will be built at an early day.

In view of the probable future increase of the collection, it seemed desirable that the principal buildings should be planned in such a way as to admit of possible extension. It was also thought best that all structures should be of a character adapted to the retired and picturesque natural scenery of the neighborhood. Imposing buildings, even if they could have been constructed within the small sums allotted by Congress, would have been out of place and calculated to mar the restful effect of the quiet valley in which they were located.

The offices of the park were established in an old and dilapidated mansion, the only dwelling found upon the whole area of the site. This mansion is one of the earliest built in this region, dating back to 1805, and is in a most picturesque spot encircled by a broad sweep of Rock Creek. Its isolated situation makes it especially suitable for any matters of administration desirable to remove from the general public, such as laboratory work, the seclusion of sick animals, and the growth of plants and shrubs for the grounds.

During the first year the entire park was fenced in, a single roadway was established extending through the area just referred to, and the creek was spanned by an inexpensive bridge.

While it would have been desirable to prepare at once houses for different classes of animals, so that each could have the treatment most appropriate to its needs, it was impossible, for want of funds, to arrange for more than one house which should shelter animals requiring heat during

winter. This included both animals from the valley of the Amazon, that never in their native haunts experience great changes of temperature, and those from the southern portion of the United States, that thrive better when exposed to considerable vicissitudes. The carnivorous nocturnal animals had to be housed with the timid herbivorous ones naturally wakeful by day. Experience has shown, as was expected, that better results would have been obtained had it been possible to separate these groups.

The animals turned over to the management of the National Zoölogical Park were one hundred and eighty-five in number, large and small. They had been kept huddled together in such temporary quarters as could be provided in a low shed and a few small paddocks upon the south side of the Smithsonian building. They were then transferred to their permanent quarters at the park.

The experience of the first year was in every way favorable. Great interest was taken by the public in the new enterprise, a considerable number of valuable gifts were made, among which was an Asiatic elephant presented by Mr. J. E. Cooper, of the Forepaugh shows. A few valuable specimens were purchased as opportunity offered of obtaining them at reasonable figures. The whole enterprise took on a healthy growth, and was evidently firmly established.

During the next year the mutations of politics caused a change in the dominant political party, and there were elected to the House of Representatives a large number of new members to whom the park was a totally unknown project. The Committee on Appropriations no longer regarded it favorably, and the annual estimates, which were made only with reference to the proper and economical development of the original design, were much reduced. Further than this, the authority to increase the collection by the purchase of ani-

mals, which had been contained in the previous appropriation acts, was withdrawn, and it was evidently intended to restrict the operations of the park as much as possible. Indeed the question of abolishing it altogether was at one time considered, but better counsels finally prevailed. This policy naturally retarded to a considerable extent the growth so auspiciously commenced. Instead of permanent structures suited to the needs of each class of animals, temporary makeshifts were necessarily erected, which, requiring to be frequently repaired and renewed, involved in the end a waste of public money.

In no matter was this policy more injurious than in its effect on the growth of the collection. It now became impossible to procure specimens except by gifts, by transfer, or by collecting them at great expense within the limits of government preserves, like the Yellowstone National Park. Experience has shown that the increase by gifts is very precarious. The animals given are, it is true, sometimes very valuable; often, however, they are diseased or defective in some way. They are usually the random, accidental finds made by chance sportsmen or curiosity hunters, and are, naturally, more numerous in certain classes than in others. Numbers of opossums, raccoons, and small alligators are yearly presented, but no one has ever thought of presenting a moose, a caribou, a manatee, a sea-lion, or any of the important animals for the preservation of which the park was especially instituted.

The increase by transfer really amounts only to this, that certain of the animals bred within the park may, if any one chances to want them, be exchanged for others. Native American animals are not much used in menageries, and there is, therefore, but little demand for them. Slight use has, therefore, been made of this privilege.

By the kind coöperation of the Secretary of the Interior, permission was given to the Smithsonian to make collections of wild animals within the Yellowstone National Park. This has become the only source of supply for certain species. It was hoped that large numbers of buffalo, elk, deer, antelope, moose, and beaver might be obtained there, and considerable sums have been expended for the purpose of building corrals and paddocks within that park for the capture and temporary confinement of animals and their transportation to Washington. This has proved an expensive undertaking. The isolation of the Yellowstone Park enhances greatly the prices of labor and material there, and its great distance from this city makes the charges for transportation amount to as much or more than the value of the animals.

Some interesting results have, however, been attained. A colony of beavers was, with considerable difficulty, collected and placed in the National Zoölogical Park, where the animals at once made themselves at home and proceeded to build a lodge and several dams after the most approved fashion. It was thought that it would be necessary to isolate them entirely from the public, but it is found that they readily become tamed, those which have been properly treated having no fear of man, eating from the hand and carrying on their building operations undisturbed by the presence of the public.

With regard to results attained by the park, it may be said that the popular interest in the collection is very great. On Sundays and holidays the walks and buildings are crowded with visitors, and any important accessions at once increase the throng. On several occasions the attendance has exceeded ten thousand a day, and once, when a considerable number of new animals had just arrived, it nearly reached thirty thousand by actual count. Classes of children from the public schools are constantly seen during fine weather,

in the school season, carefully examining the animals and noting their characteristics under the guidance of their teachers, who in this way are enabled to give them definite instruction in the elements of natural history. Art students may often be seen making studies from life, drawing, painting, and modeling the animals. To the taxidermist such studies are invaluable and indispensable.

It is, of course, impossible, even with as generous an area as that afforded in the National Zoölogical Park, to reproduce perfectly the conditions of nature. It would not be practicable to give to moose a large forest in which to browse, or to caribou a growth of the arctic lichens and mosses upon which they thrive. Neither would it be desirable to allow the animals to prey upon each other as they do in a state of nature. It is, however, perfectly possible to keep them in reasonable health and activity, and to present them to the public in conditions that are far more instructive than those which prevail in ordinary institutions of the same sort.

One of the best tests of the salubrity of the conditions under which the animals are kept is the readiness with which they breed. The buffalo, elk, deer, panther, wild-cat, and even the black bear, beaver, and porcupine, have all brought forth young. In the case of the bear this result has rarely been attained in captivity. There is no reason to doubt that any of our native animals that can endure this climate will increase without difficulty if appropriately treated.

The collection, though far from what it might be, is an excellent beginning. As the enterprise was conceived mainly in the interest of preserving animals likely to become extinct, much more attention has been given to native than to exotic species. Herds of buffalo, of llamas, of elk, and of deer have been formed. Two teams of Esquimaux dogs, one presented by Mrs. Peary, and one loaned by Mr. Bruce, have bred

freely, and the animals appear to endure the heat of our summers without serious inconvenience. A collection of domestic dogs, intended to show the great variation of that species by typical examples of well recognized breeds, has been commenced.

A few valuable exotic animals have been presented to the park. Besides the large elephant given by Mr. J. E. Cooper, there is a fine lion brought from the Matabele country of central Africa by Mr. H. C. Moore; a female leopard from the headwaters of the Congo by Mr. R. Dorsey Mohun, and a zebu presented by Mr. J. H. Starin.

It is hoped that all the restrictions that impede the growth of the collection will in time be removed. Purchase of animals should be allowed, both because it is the only practicable way of properly keeping up the collection, and because it is desirable that certain exotic species should be introduced for purposes of comparison. Unless this is done the park must necessarily be relegated to a low rank as compared with other zoölogical collections.

A considerable amount of material for study is derived from the animals that die in the park. If suitable for museum specimens their skins and skeletons are preserved by the United States National Museum. It is hoped soon to establish a suitable laboratory for the adequate anatomical and pathological investigations of this material, as is done in connection with all European collections of living animals. This promises much for the advancement of biological sciences, for the anatomy of many of the rarer American animals is imperfectly known, and many of the diseases of animals in confinement are obscure and but little understood.

The future success of the park cannot be doubted. Popular interest everywhere is being awakened upon the subject of the preservation of game and the care of animals in cap-

tivity. In New York City a zoölogical society has been formed which has recently had set aside for its use a tract of land in one of the public parks two hundred and sixty-one acres in extent. Upon this it is intended to erect buildings at a cost of two hundred and fifty thousand dollars, and to maintain a large collection of animals both native and foreign. It would seem proper that the National Park should have an establishment at least equal to this. A feeling of national pride should lead all public-spirited citizens to take an active interest in the increase and suitable maintenance of the collection. At present it is not as widely known as it should be. When United States officials in all parts of the world become interested in its advancement, it is believed that the scope of the enterprise will be vastly increased.

EXPLORATION WORK OF THE SMITHSONIAN INSTITUTION

BY FREDERICK WILLIAM TRUE

TO give a just conception of the work of the Institution in connection with explorations in the brief space which can be afforded in this volume, is a task of much difficulty. Its influence has been exerted in a thousand directions, and the extent and manner of its coöperation have varied greatly in different instances. Furthermore, from its policy of aiding where aid seemed most needed, it has very naturally joined in enterprises from year to year which had no essential connection with one another. In a single year it assisted in explorations in Alaska, in Ecuador, and in Ohio. The character of the explorations in which the Institution has interested itself has varied no less than the field they cover. While it may perhaps be said that more aid has been rendered to zoölogical exploration than any other, researches in anthropology, botany, geology, and geography have also received a large share of attention.

Though frequently showing itself willing to bear the burden of expense, the funds of the Institution have never been sufficient to enable it to defray the whole cost of explorations

of great magnitude. Fortunately, so far as North America is concerned, the government of the United States, a few years after the founding of the Institution, inaugurated a great series of surveys for railroad routes across the continent, and for the delimitation of boundary lines. These have been followed by general topographical and geological and biological surveys, and by explorations of the coasts and of the rivers and lakes in the interest of commerce and the fisheries. An extensive knowledge of the characteristics and natural resources of the continent has thus been obtained very largely at the expense of the general government. Yet in all these undertakings the influence of the Institution has been felt, and its aid has been of importance. Especially was this true in the earlier years of its history, when the participation of the government in scientific research was less extensive and less varied than at present. In many lines the Institution was a pioneer, and the government interested itself only after the importance and the practical bearings of the investigations had been demonstrated.

In explorations, perhaps, more than in any other form of activities, the peculiar workings of the policy of the Institution can be seen to advantage. Established "for the increase and diffusion of knowledge," its rule has nevertheless been that of "not expending the Smithson fund in doing with it what could be equally well done by other means"; but, on the other hand, it has endeavored to foster those worthy enterprises which seemed likely to fail for want of proper support. In explorations, as in other lines of work, it has not entered into competition with kindred organizations, but has endeavored to make their work broader and more successful, without the expectation of advantage to itself. It has not sought the credit which attaches to the management of great explorations, but has found satisfaction in aiding other or-

ganizations to bring their labors in the cause of science to fruition.

In the plan of organization of the Institution, among examples of objects for which appropriations may be made, the following are cited:

"Explorations in descriptive natural history, and geological, magnetical, and topographical surveys, to collect materials for the formation of a Physical Atlas of the United States.

"Ethnological researches, particularly with reference to the different races of men in North America; also explorations and accurate surveys of the mounds and other remains of the ancient people of our country."[1]

It so happened that the first scientific memoir submitted to the Institution for publication was one on American archæology — the now famous work of Squier and Davis on the "Ancient Monuments of the Mississippi Valley; comprising the results of Extensive Original Surveys and Explorations." This work was submitted to the Secretary of the Institution, May 15, 1847, and by him referred to the American Ethnological Society, of which Albert Gallatin was President. The committee which examined it reported it "worthy of the subject and highly creditable to the authors," and its publication by the Institution was therefore undertaken. The Institution by this action expressed its recognition of the importance of scientific explorations, and has shown a continued interest in work of this character by publishing, year by year, in the "Contributions" or the "Report," the results of other field investigations in zoölogy, botany, geology, and ethnology.

The publication of Squier and Davis's work awakened an interest in American archæological investigation which has

[1] "Smithsonian Report," 1846, pages 6 and 7.

ever since been kept alive. In 1849, a few years after the appearance of the first volume, the Institution evinced its continued interest in this subject by publishing a work by Squier on the antiquities of New York, based on explorations made at the joint expense of the Institution and the Historical Society of New York.

The same year the Institution lent its aid in the increase of the knowledge of the physical geography of the United States by publishing a treatise on the hydrography of the Ohio River "from actual surveys," written by Charles Ellet, the engineer of the first Niagara suspension-bridge.

In the direction of botanical explorations, the first aid rendered by the Institution took the form of a small appropriation for the expense of an expedition to Texas, in 1849, by Charles Wright, under the direction of Asa Gray. The results of this expedition were published in the "Contributions" in 1852 and 1853.[1]

Of the collections made at that time Professor Henry remarked:

"Specimens of all the plants obtained by Mr. Wright belong to this Institution; and these, with sets collected by Fendler and Lindheimer, form the nucleus of an important and authentic North American herbarium."[2]

The sixth volume of the "Contributions," published in 1854, contained a paper by Torrey on the botany of California, based on the explorations of Frémont.

At this early day the Institution also rendered aid to explorations of especial importance to paleontology. In the Report for 1850, Professor Henry remarked:

"The programme of organization contemplates the institution of researches in Natural History, Geology, etc.; and

[1] Gray, Asa, "Plantæ Wrightianæ Texano-Neo-Mexicanæ." Part 1, 1852; part 2, 1853.

[2] "Smithsonian Report," 1851, page 11.

though the state of the funds would permit of little being done in this line, yet we have made a beginning. Besides the assistance rendered to the exploration of the botany of New Mexico, by the purchase of sets of plants from Mr. Wright and Mr. Fendler, as mentioned in my last Report, a small sum was appropriated to defray the cost of transportation of the articles which might be collected by Mr. Thaddeus Culbertson in the region of the Upper Missouri. This gentleman, a graduate of the institutions at Princeton, had purposed to visit the remote regions above mentioned for the benefit of his health, and was provided by Professor Baird with minute directions as to the preservation of specimens and the objects which should particularly engage his attention.

"Mr. Culbertson first visited an interesting locality called the *Mauvaises Terres*, or Bad Lands, where his brother had previously found the remains of the fossils sent to the Academy [of Natural Sciences, Philadelphia].

"He afterwards ascended the Missouri to a point several hundred miles above Fort Union. . . . Though he had withstood the privations and exposures of the wilderness, he sank under an attack of a prevalent disease, and died after a few weeks' illness.

"He left a journal of all the important events of his tour, which is thought of sufficient importance to be appended to this report."[1]

While doing what it could to make successful the memorable journey of Culbertson, the Institution at the same time lent its aid to geological exploration by defraying a portion of the expense of researches of Professor E. Hitchcock, of Amherst College, on the subject of erosion by rivers, and also relative to ancient sea beaches and terraces. The results of this work were published later, at large expense, in the ninth volume of the "Contributions."

Thus the Institution made a beginning in many lines of exploration.

[1] "Smithsonian Report," 1850, page 19.

In connection with the explorations of Culbertson, already mentioned, we first learn of the association of Professor Baird with this branch of the work of the Institution. His services had been recently engaged by the Institution, and he was destined to play a most important part. Himself an enthusiastic explorer in many lines of natural history, and withal a man of most engaging conversation and industrious habits, he was able greatly to aid the cause of exploration both by supplying thoroughly practical directions for observation and by impressing on those in authority the importance of investigations of natural phenomena.

He was appointed Assistant Secretary of the Institution in 1850, and only three years had passed when the great series of Pacific Railroad surveys and the Mexican boundary survey were undertaken by the government, while at the same time very numerous minor explorations, both under government and private auspices, were instituted. Of the two years 1853 and 1854 Professor Baird writes:

"The number of important scientific explorations embraced in this period mark it conspicuously in the history of American discovery. Most of these are due to the appropriation for the survey of the China seas and Behring's Straits, and that for a survey of the several routes for a railroad to the Pacific (although many more private expeditions were set on foot), in addition to the regular operations of the United States and Mexican Boundary Survey, whose labors during the past years were in continuation of those commenced before. Many reports of explorations, commenced or completed prior to 1853, have been published during this period."[1]

He gives an account of twenty-six important explorations undertaken in these two years, including the six Pacific Rail-

1 "Smithsonian Report," 1854, page 79.

road surveys, and of nineteen reports of explorations which were published during the same period.

Of the participation of the Institution in these great activities, he writes:

"With scarcely an exception, every expedition of any magnitude has received more or less aid from the Smithsonian Institution. This has consisted in the supplying of instructions for making observations and collections in meteorology and natural history, and of information as to particular desiderata; in the preparation, in part, of the meteorological, magnetical, and natural history outfit, including the selection and purchase of the necessary apparatus and instruments; in the nomination and training of persons to fill important positions in the scientific corps; in the reception of the collections made, and their reference to individuals competent to report upon them; and in employing skilful and trained artists to make accurate delineations of the new or unfigured species. Much of the apparatus supplied to the different parties was invented or adapted by the Institution for this special purpose, and used for the first time, with results surpassing the most sanguine expectations."[1]

A list of these government explorations, from the Report of 1856, may be of interest in this connection. It is as follows:

A.— GEOLOGICAL SURVEYS.

1. The survey of Wisconsin, Iowa, Minnesota, and a portion of Nebraska, by Dr. David Dale Owen.

2. The survey of the Lake Superior district, by Dr. Charles T. Jackson.

3. The survey of the same region, by Messrs. Foster and Whitney.

4. The survey of Oregon, by Dr. John Evans.

[1] "Smithsonian Report," 1854, page 79.

B.— BOUNDARY SURVEYS.

5. The survey of the line between the United States and Mexico, first organized under Honorable J. B. Weller, as commissioner, and Major W. H. Emory, as chief of the scientific department, then under John R. Bartlett, commissioner, and Colonel J. D. Graham, chief of the scientific corps, succeeded subsequently by Major W. H. Emory, then under General R. B. Campbell, commissioner, and Major W. H. Emory, chief of the scientific corps.

6. The survey of the boundary line of the Gadsden purchase, under Major W. H. Emory, commissioner.

C.— SURVEYS OF A RAILROAD ROUTE TO THE PACIFIC.

7. Along the 47th parallel, under Governor I. I. Stevens.

8. Along the 38th and 39th parallel, under Captain J. W. Gunnison.

9. Along the 41st parallel, under Captain E. G. Beckwith.

10. Along the 35th parallel, under Lieutenant A. W. Whipple.

11. In California, under Lieutenant S. R. Williamson.

12. Along the 32d parallel, western division, under Lieutenant J. G. Parke.

13. Along the 32d parallel, eastern division, under Captain J. Pope.

14. In a portion of California, under Lieutenant J. G. Parke.

15. In northern California and Oregon, under Lieutenant R. S. Williamson.

D.— MISCELLANEOUS EXPEDITIONS UNDER THE WAR DEPARTMENT.

16. Expedition along the 32d parallel, eastern division, for experimenting upon artesian borings, under Captain Pope.

17. Exploration of Red River, under Captain R. B. Marcy.

18. Survey of Indian reservation in Texas, under Captain R. B. Marcy.

19. Exploration of the Upper Missouri and Yellowstone, under Lieutenant G. K. Warren.

20. Construction of a wagon-road from Fort Leavenworth to Bridger's Pass, under Lieutenant F. T. Bryan.

E.—NAVAL EXPEDITIONS UNDER THE NAVY DEPARTMENT.

21. The United States naval astronomical expedition in Chile, under Lieutenant J. M. Gilliss.

22. The Japan expedition, under Commodore M. C. Perry.

23. Exploration of the China seas and Behring's Straits, first under command of Captain C. Ringgold, then under Captain J. Rodgers.

24. Exploration of the La Plata and its tributaries, under Captain T. J. Page.

25. Exploration of the west coast of Greenland and Smith's Sound, under Dr. E. K. Kane.[1]

The participation of the Institution in explorations conducted by the government continued actively for many years, though the character of these explorations as a whole has varied in the course of time. The surveys for railroad routes and wagon-roads across the public lands of the West form the first important series of explorations in which the Institution was interested. Next after these interest centered in the extensive geological surveys of the same region. After these came the explorations of the sea-coast, rivers, and lakes of the United States by the Fish Commission, and investigations of the North American Indians by the Bureau of Ethnology.

In the case of the geological surveys, although the work done was more strictly scientific in character than that of

[1] "Smithsonian Report," 1856, page 61.

many of the earlier surveys, the government supplied sufficient means both for equipment and for publication, and the Institution was seldom appealed to for aid. Its connection with these government organizations was therefore, on the whole, a more indirect one than in the case of the earlier surveys.

It became the custodian, however, of large collections, chiefly zoölogical, made by naturalists and surgeons connected with the field parties. To these same naturalists, when they returned from the field, the Institution opened its great stores of natural history material, and supplied workrooms; and in many of the zoölogical treatises published by the geological and geographical surveys, by way of illustration, we find acknowledgment of the assistance rendered.

Thus, Doctor J. A. Allen, in his monographs of the North American hares published in the eleventh volume of the quarto reports of the United States Geological Survey of the Territories, under the direction of Doctor F. V. Hayden, remarks:

"The author has thus had access not only to the types of the species described by Professor S. F. Baird in his great work on the 'Mammals of North America,' published in 1857, but also to nearly all the material used by him in his excellent elaboration of this family in the above-named work, together with the vast amount of material that has since accumulated at the Smithsonian Institution. This includes not only the collections made by the different government expeditions since 1857, but also the large collections made since that date, under the auspices of the Smithsonian Institution, in Alaska, the British Possessions, Mexico, and Central America. By far the larger portion of the specimens examined from localities within the United States received from any one source have been the collections made either by Doctor F. V. Hayden personally or under his immediate

direction, and especially during the prosecution of the geographical and geological survey of the Territories, now [1876] in progress, under the auspices of the Department of the Interior."[1]

In the prefatory note by Doctor Hayden in Doctor Elliott Coues's work on "Fur-bearing Animals," which was published by the United States Geological Survey of the Territories in 1877, we read:

"The Memoir is based upon specimens secured by the Survey under my direction, together with all the material contained in the National Museum, for the opportunity of examining which the Survey acknowledges, in this as in other instances, its indebtedness to the Smithsonian Institution."[2]

The interest which the Institution has had in the explorations of the United States Fish Commission has been of a special character, due to the fact that the first Commissioner, Professor Baird, was an Assistant Secretary of the Institution, and afterward its Secretary.

He served without compensation, and his status was, therefore, that of an officer of the Institution engaged in important scientific explorations and investigations for the benefit of the government and the people. On this point Professor Henry remarked in 1877:

"It will be seen from the report of Professor Baird that a large amount of his time has been expended in labor for the general government, in relation to American fisheries.

"Almost from the first organization of the Institution until the present time the officers of the Institution have rendered

[1] Volume XI, page 267, Washington, 1877.

[2] Coues, Elliott, "Fur-bearing Animals: A Monograph of North American Mustelidae." United States Geological Survey of the Territories, Miscellaneous Publications, No. 8, page 4, Washington, 1877.

service to the general government without additional salary."[1]

The operations of the Commission were reported upon briefly by the Secretary of the Institution, from year to year, and the manifold importance of the explorations was frequently insisted upon. In the Report just quoted from, Professor Henry remarked: "The labors of the United States Fish Commission can scarcely be too highly estimated."[2]

The history of the Commission cannot be more than lightly touched upon here.

In his first report Professor Baird acknowledges the aid received from the Institution through the loan of nets, dredges, and other apparatus, whereby the Commission was saved "the considerable outlay which would otherwise have been necessary." An equipment was soon secured which was improved year by year, and at last received its most important addition in the form of a sea-going steamer, the *Albatross*, which enabled the Commission to carry on explorations of the highest scientific interest in the deep sea, off the coasts of the United States — a considerable portion of the results of which have been or are being published under the Institution.

The Bureau of American Ethnology is the most recently organized bureau concerned in explorations with which the Institution has had intimate relations; but the subjects dealt with, as I have already stated, were among the earliest which it lent its aid in elucidating.

"It is well known," wrote Secretary Baird in his report for 1879, "that the natural history of primitive man, especially in North America, has always been a special object of the attention of the Smithsonian Institution. The first vol-

1 "Smithsonian Report," 1877, page 51.

2 *Ibidem*, page 50.

ume of its series of publications consisted of a work by Messrs. Squier and Davis, entitled 'The Ancient Monuments of the Mississippi Valley,' which, appearing in 1848, gave a stimulus to archæological research in America, and aided greatly in exciting that high degree of interest in the subject which now pervades the whole country. The work, although thirty years old [in 1878], is still a standard publication, and greatly sought after."[1]

An account of the history of the Bureau of Ethnology will be found in another part of this volume, and it will suffice here to remark that it originated with the explorations of the Colorado River by Major J. W. Powell in 1867, 1868, and 1869, which were fostered by Professor Henry, and were extended afterward into a survey of the Rocky Mountain region under the direction of the Institution.

The ethnological investigations were finally separated from those relating to geography and geology, and in 1879 were placed in the hands of a special bureau, under the direction of the Institution.

In 1875 Secretary Henry, taking cognizance of the work then being carried on by Major Powell, placed in his care, in accordance with the policy pursued in all similar cases, the linguistic manuscripts belonging to the Institution. The Secretary remarked:

"For a number of years the Institution has been collecting, as a part of its work in the line of ethnology, Indian vocabularies, and of these the number amounts to 670. . . . It was the intention of the Institution to publish these vocabularies as a part of the volumes of the Smithsonian Contributions to Knowledge, and also in a separate form for more general distribution to philologists actually engaged in the comparative study of languages of savage tribes. An offer, however, was made by Major J. W. Powell, who had also

[1] "Smithsonian Report," 1879, page 38.

collected a series of Indian vocabularies, to adopt those of the Institution, and to publish the whole in connection with his researches under government in regard to the ethnology of the Indian tribes inhabiting the country watered by the tributaries of the Great Colorado of the West. In accordance with the general policy of the Institution in not expending its funds on anything which can be as well done by other means, the proposition of Major Powell was accepted, the only conditions exacted on which the transfer was made being that full credit should be given in the publication to the name of Smithson for collecting and arranging the articles, and also that extra copies be furnished the Institution for liberal distribution."[1]

For eighteen years the Bureau of Ethnology has carried on important investigations of the distribution, languages, customs, and beliefs of the North American Indians, and has published a valuable series of works relating thereto. A detailed account of the labors of the bureau has been given by Mr. McGee in an earlier chapter of this volume, and need not be recounted here.

The coöperation of the Institution in government explorations cannot be dwelt upon more at length, and it is necessary to return to the consideration of the explorations which were set on foot through its influence and encouragement and were sustained as far as possible by grants of money. The number of these explorations is very great, and the territory they cover is of vast extent. In importance also they have varied greatly, and some — a majority perhaps — are no more than collecting excursions. Yet, as no earnest collector of natural objects in the field can fail to make new observations of more or less value, even these collecting expeditions may perhaps fairly be regarded in the light of explorations. The policy adopted by the Secretaries

[1] "Smithsonian Report," 1876, page 35.

of showing by prompt and full correspondence the appreciation of the Institution of labors in the cause of science, however small, has led to the formation of an army of zealous collaborators, scattered throughout the world, who are always willing to advance the work of the Institution and to add to the collections which have grown up in the National Museum under its charge. Indeed, it seems to have become a fixed belief in many parts of the United States that all scientific explorations in the country are conducted by the Smithsonian Institution, and that all explorers are its agents. The fruits of these hundreds of minor explorations are to be found in the collections of the National Museum, and the names of thousands of contributors are inscribed in its record-books. A simple list of these correspondents and their donations covers a score or more of pages in each annual Report, and it would be obviously impossible to do justice to such a roll in the space here available.

It is desirable, however, to make mention of a few explorations which show the generous response of individuals and organizations to the endeavors of the Institution for the advancement of science. One of the earliest of these was the exploration of the prehistoric mounds of Wisconsin by the American Antiquarian Society, in relation to which Secretary Henry made the following interesting statement in the Report for 1851:[1]

"The most interesting circumstance connected with the study of the ancient remains of this country is a recent action of the American Antiquarian Society of Worcester, Massachusetts. This Institution was founded in 1812 by the zeal and liberality of Isaiah Thomas, for the purpose of collecting and preserving such manuscripts, pamphlets, and other articles as relate to the history of this country, and for the explora-

[1] Page 18.

tion and publication of its antiquities. It was at the expense of this society that the original researches of Mr. Atwater, on the mounds of the Ohio Valley, were first published; and during the last two years the condition of its funds has again enabled it to take the field, and to direct its attention to the remarkable antiquities in the State of Wisconsin.

"These antiquities, it is well known, consist of representations, on a gigantic scale, of birds, beasts, and fishes; and though many of them have been surveyed, and accounts of them given in the memoir of Messrs. Squier and Davis, comparatively few of those which are said to exist have been explored or delineated. For this reason, the council of the society have engaged Mr. I. A. Lapham, an experienced engineer, to make the explorations and surveys and drawings of these mounds. He has been engaged in these operations for two seasons, and is now employed in making up an account of his labors.

"To insure harmony of action in the cultivation of the wide field of research offered in the investigations of the ancient monuments of this country, the Antiquarian Society has agreed to present to the Smithsonian Institution the results of the explorations of Mr. Lapham for publication, and to reserve its limited funds for further explorations. The memoirs will be examined and revised by the society, and will be published under its auspices in the Smithsonian Contributions.

"This arrangement is another pleasing evidence of the feeling with which the efforts of this Institution are regarded, and the willingness with which other Institutions coöperate with it in the important work of promoting original knowledge."

The results of this exploration were published in the seventh volume of the "Contributions to Knowledge."

The exploration of California by E. Samuels in 1855 is another interesting example of friendly coöperation, not only on the part of scientific organizations, but of private business

corporations as well. Secretary Henry's statement in the Report of 1856 is as follows:

"Brief mention was made in my last report of the fitting out of Mr. Samuels by the Boston Society of Natural History and the Smithsonian Institution, aided by the liberality of the United States mail line to California, via Panama. Mr. Samuels returned in July last, having thoroughly explored the field of his labors, and gathered a rich collection of specimens, embracing many rare and new species. The liberal promises of the Pacific Mail Steamship Company, the Panama Railroad Company, and the United States Mail Steamship Company have been more than realized in the free passage home given to Mr. Samuels and all his large collections—an act of generosity which may well excite the attention and recognition of the lovers of science. Nor should less meed of praise be awarded to Messrs. Wells, Fargo & Co. for their free transmission to San Francisco of Mr. Samuels' boxes, thus facilitating their semi-monthly despatch to Washington.

"It may, perhaps, not be out of place here to state that the above-mentioned mail line still continues its kind offices by transporting, free of charge, all packages of the Smithsonian Institution containing books of specimens of natural history. The United States mail line, also, has furnished free freight of a similar character from Cuba and New Orleans to New York.

"The results of Mr. Samuels' explorations will shortly be published in connected form in the journal of the Boston Society of Natural History, illustrated with the necessary plates and figures."[1]

The notable explorations of Robert Kennicott in British America and Alaska were made possible by the coöperation of several private individuals and scientific organizations and the Hudson Bay Company. This intrepid explorer, whose early death was a severe loss to American natural history,

[1] "Smithsonian Report," 1856, page 52.

spent four years in the North and made most extensive travels.

"During the whole exploration he was the guest of the Hudson's Bay Company, the officers of which not only furnished him with free transportation for the materials he collected, but also extended to him in the most liberal manner the hospitalities of their several posts, and facilitated in every way in their power the objects of his perilous enterprise.

"The principal object of the exploration was to collect materials for investigating the Zoölogy of the region visited. Mr. Kennicott, however, also collected specimens of plants and minerals, and gave considerable attention to the ethnology of the country, in observing the peculiarities of the various Indian tribes, and forming vocabularies of the languages. He carried with him a number of thermometers, and succeeded in enlisting a number of persons as meteorological observers, as well as in exciting an interest in natural history and in physical phenomena which cannot fail to be productive of important information respecting a region of the globe but little known."[1]

The interest aroused by these investigations has never completely died out, and the Institution received year by year for a long period the fruits of explorations carried on by officers of the Hudson Bay Company in many parts of the British territory.

Following immediately upon Kennicott's explorations, an expedition was sent out under private auspices to Alaska and Siberia for the purpose of establishing an overland telegraphic route between America and Europe. The enterprise failed as a financial venture on account of the success of the Atlantic cable, but large benefits accrued to science from the labors of the naturalists who accompanied the expedition.[2]

1 "Smithsonian Report," 1862, page 40.

2 For an extended account of this expedition, see *Science*, 1896, Volume III, pages 37 and 87.

"The telegraph company not only afforded facilities for making the collections, but also contributed, as did the Chicago Academy of Sciences, to lessen the expense to the Smithsonian fund in the purchase of the necessary articles comprising the outfit of the naturalists of the expedition."[1]

After the disbanding of the telegraph expedition one of the naturalists, William H. Dall, remained in Alaska and made explorations particularly in the region of the Yukon River. The support of his labors is a notable instance of the coöperation which has existed between the Smithsonian Institution and other scientific and non-scientific organizations. Mr. Dall defrayed the first cost of his expedition from private funds; the transportation of his collections from the west coast was undertaken by the Pacific Mail Steamship Company; and the expense attending their elaboration was borne jointly by the Boston Society of Natural History and the Smithsonian Institution, which latter furnished the necessary work-rooms.

Mention has already been made of the services rendered to science by the medical officers attached to the various government surveying parties. Hardly less important have been the activities of the army surgeons stationed at the military posts of the West. In the years when the Institution was paying special attention to the investigation of the aborigines of America, the pages of the annual reports are thickly dotted with the names of medical officers who rendered important service in this line of exploration. The great collections of the National Museum tell of their zeal, which even at the present day has suffered no abatement, though the spread of population and the cultivation of waste places have in large measure lessened opportunities.

Other branches of the public service no less than the army

[1] "Smithsonian Report," 1865, page 61.

have coöperated extensively with the Institution in exploring the national domain, and there is hardly a department or a bureau of the government whose operations include field work which has not at some time joined with the Institution in investigations. The good offices of the State Department, the Navy Department, the Weather Bureau, the Life-saving Service, the Lighthouse Board, the Land Office, the Indian Bureau, and the Bureau of Education, come at once to mind in this connection. In 1864, Professor Henry wrote in his Report:

"In addition to the collections which have been received from explorations organized under the direction of the Institution, large numbers of duplicate specimens have been presented by the meteorological observers and other Smithsonian collaborators, the whole forming a body of material for the illustration and study of the products of the American continent unequalled by any collection previously made. The explorations, however, as might be inferred, have not been confined to the collecting of specimens, but have also furnished information relative to the topography, geology, physical geography, ethnology, and the living fauna of the regions visited."[1]

Though the explorations in which the Institution has interested itself have centered chiefly in North America, its influence has also extended to other parts of the world. As an example may be cited the survey of Yucatan. This was undertaken by Governor Salazar y Ilarregui in 1865, who, upon the recommendation of the Institution, appointed Doctor Arthur Schott to take charge of natural history operations.[2]

The same year an exploration of British Honduras was undertaken by Doctor H. Berendt, under the auspices of the Institution.

[1] "Smithsonian Report," 1864, page 50. [2] *Ibidem*, 1865, page 62.

"The outfit of physical instruments and apparatus, and supplies, for collections of natural history, were principally furnished from the Smithsonian fund, while the personal expenses were borne by a subscription of a number of gentlemen interested in the advance of science, and by the Academies of Natural Sciences of Philadelphia and Chicago."[1]

In 1867 an exploration of the northern parts of South America was made by the Lyceum of Natural History of Williams College, Massachusetts, under Professor James Orton, and the Institution furnished instruments and a considerable part of the necessary outfit, and took charge of the transportation of the collections made.[2]

In 1882 an expedition to the Commander Islands in the North Pacific was arranged for by the Institution, and Doctor Leonhard Stejneger was selected for the work. One of the special tasks committed to him was to collect bones of the extinct Arctic sea-cow. His transportation was secured through the Alaska Commercial Company, a corporation which has always been ready to aid the Institution in scientific enterprises. Doctor Stejneger obtained large collections, including skulls and bones of the sea-cow, which were the special object of his quest.

In 1883 Pierre L. Jouy, who has been in the service of the Institution for a number of years, accompanied Honorable Lucius H. Foote to Korea upon the occasion of the inauguration of official intercourse with that country, and later connected himself with the civil service of the Korean government. He made valuable observations and collections while so engaged. Lieutenant J. B. Bernadou, U. S. N., also explored Korea under the auspices of the Institution.

Important explorations in the East, especially in Mongolia and Tibet, were conducted, partly under the auspices of the Smithsonian Institution, by Honorable William W. Rockhill,

1 "Smithsonian Report," 1865, page 62. 2 *Ibidem*, 1867, page 49.

in 1888–89 and 1891–92. Mr. Rockhill was especially fitted for such work in view of his connection with the United States Consular Service in China during several previous years. At the time of revisiting the East he obtained much interesting information concerning the manners and customs of the people, and made extensive collections. An account of his last journey was published by the Institution under the title of "Diary of a Journey through Mongolia and Tibet in 1891 and 1892." Another illustrated paper by Mr. Rockhill, on the "Ethnology of Tibet," in which his collections are described, was published in 1893.[1]

In 1890 an expedition was sent to the west coast of Africa to observe an eclipse of the sun, and the Institution was afforded an opportunity to send an assistant of the National Museum to make natural history observations.

These are but a few examples from a large series of foreign explorations in which the Institution has taken a more or less prominent part. The appreciation of its labors in foreign fields has been manifested in various ways, and perhaps in no more conspicuous manner than by the generous action of Doctor William L. Abbott, who has presented the fruits of his own extended explorations in Africa and Asia to the Institution.

Thus it is manifest that the Smithsonian Institution has contributed to the work of exploring the domain of nature not only directly by setting on foot expeditions supported from its own funds, and indirectly by aiding and equipping numerous government and private expeditions, but more remotely as well by influencing independent workers to explore in many lands, and to add new treasures to the national collections.

[1] "Report of the United States National Museum," 1893, page 665.

THE SMITHSONIAN PUBLICATIONS

By Cyrus Adler

It is chiefly by the publications of the Institution that its fame is to be spread through the world, and the monument most befitting the name of Smithson erected to his memory. —Henry.

THAT a portion of the income arising from the Smithson bequest should be devoted to the publication of scientific memoirs was an idea early advanced in the course of the discussion relating to its application. In the year 1840, Peter S. Duponceau, then president of the American Philosophical Society, described the benefit which that society had received from the publication of a bulletin containing its own proceedings.

One of the favorite plans for the application of the Smithson Fund was the establishment of an Astronomical Observatory. The bills which would have authorized this disposition of the fund were introduced into Congress in 1839, in 1841, and again in 1844. All of these bills directed that the sum of $30,000 be set aside, the income of which was to be used for the printing of a nautical almanac, to be known as the "Smithson Almanac." In a bill introduced into the House of Representatives February 28, 1846, by Mr. Robert Dale

Owen, for the establishment of the Institution, the following provision for publications was contained:

SECTION 10. "*And be it further enacted*, That it shall be competent for the board of managers to cause to be printed and published periodically or occasionally essays, pamphlets, magazines, or other brief works or productions for the dissemination of information among the people, especially works in popular form on agriculture and its latest improvements, on the sciences and the aid they bring to labor, manuals explanatory of the best systems of common school instruction, and generally tracts illustrative of objects of elementary science and the rudiments of history, chemistry, astronomy, or any other department of useful knowledge; also, they may prepare sets of illustrations, specimens, and apparatus, suited for primary schools."

Another proposition was submitted by Mr. Giles of Maryland, "providing for the publication and distribution of books for the instruction of the blind."

The act establishing the Smithsonian Institution did not directly specify that publications should be issued. The last sentence of the third section reads: "And the said Board [of Regents] shall submit to Congress, at each session thereof, a report of the operations, expenditures, and condition of the Institution." Upon the basis of this statement, the annual Reports, the series of the Institution's publications issued in the largest edition and most widely distributed, rest.

The first Report of the Institution presented to Congress was printed as a Congressional document, and consisted of thirty-seven pages. It was devoted entirely to the business of the Board of Regents. This plan of report was followed for several years; but the importance of making this document something more than a mere record of receipts and expenditures was recognized at the outset, the committee on

organization recommending[1] that "as an additional means of diffusing knowledge, your committee suggest the publication of a series of reports, to be published annually, or oftener, containing a concise record of progress in the different branches of knowledge, compiled from the journals of all languages, and the transactions of scientific and learned societies throughout the world."

Great care was taken that these Reports should be properly distributed, the Board of Regents resolving, even before the actual publication of the first Report,[2] "That of this Report, in such form as it may be ultimately adopted, five thousand copies be printed, under the direction of the Secretary; and that he be required to transmit a copy of the same to each of the principal scientific and literary societies both in this and in other countries; and also to such individuals, of scientific or literary reputation, as he may judge likely to find interest in the proceedings of the Institution."

The second Report was a very much larger document, consisting of 208 pages, and containing the program of organization, correspondence, reports of committees, and a description of the building. When this Report was laid before the Senate, Senator Davis of Mississippi moved that a thousand additional copies be printed for the use of the Senate. In the House, objection was made to it by Mr. Johnson of Tennessee as a "cumbrous document." In 1849, when the third Report was laid before the Senate, objection was again made to printing it, this time by Senator Rhett of South Carolina. The proposition, however, was defended by Senator Davis of Mississippi. Opinion finally favored the publication of the Report, and the edition was increased to 3000 copies. Of the Report of 1850, 5000 copies were printed; and the number from that time on fluctuated, rising some

[1] "Smithsonian Report," 1846, page 23. [2] *Ibidem*, page 12.

years as high as 20,000 copies, being maintained for a number of years at 15,500 copies, the standard edition of late years being 10,000 copies.

As time went on, and the Institution had established itself in the regard of Congress and of the people, objection was rarely, if ever, raised against the printing of the Smithsonian Report. For the first thirty years, the volume was limited to 450 pages, and it never exceeded that size and often fell somewhat below it. All illustrations were furnished at the expense of the Institution; but the entire cost of the typesetting and press-work was borne by the government. From the first Report of thirty-seven pages, published in 1846, these Reports have steadily increased in size; the last published, 1894, consists of two parts, the first a Report of the Institution containing 770 pages, and the second, that of the National Museum, consisting of 1030 pages. Thus over 1800 pages annually published, in an edition of 10,000 copies at the joint expense of the government and the Institution, freely distributed to libraries and scientific men, most worthily carry out the provision of the will of Smithson for the diffusion of knowledge among men.

During the civil war, owing to the expense of paper, the general cost of labor, and the vast drain on the government's resources, the edition of the Reports was, for a few years, reduced to five thousand copies; but as stereotype plates had been made, it was provided in 1870, by act of Congress, that two thousand additional copies of the Reports for the years 1865, 1866, 1867, and 1868 should be printed. It was through the efforts of President James A. Garfield, then a representative from Ohio, that the edition of 1872 was raised to twenty thousand copies.

After the financial crisis of 1873, economy in expenditure being felt necessary, a general resolution to limit the size of

the editions of publications passed the Senate. When the usual resolution for the publication of the Smithsonian Report came up, it occasioned a debate, in which a number of distinguished senators participated. The proposition not to cut down the Smithsonian Report was championed by Senator Hamlin of Maine as follows:

"I may say in behalf of the Smithsonian Institution that I think this [report] is entirely distinct from the documents which we publish sent to us from the departments, or which emanate from our committees. This is purely a scientific work. . . . I think no man can ever examine a single report of that institution without being impressed with its great value. These reports . . . are of immense value to the world, and they are transmitted all over the world, and we receive back in exchange the scientific reports of the different societies and different governments."

Professor Henry explained the theory of the annual Reports in the following words:

"The Report of the Regents to Congress for 1858, besides an exposition of the conditions and operations of the Institution for that year, was, as usual, accompanied by an appendix containing the report of lectures, and other matter which has proved highly acceptable to a large number of intelligent persons in every part of the country. These Reports, copies of which are especially solicited by teachers, besides furnishing valuable knowledge not otherwise readily attainable, serve to diffuse information as to the operations of the Institution which tends to increase the number of its friends and coöperators, and to elevate popular conceptions in reference to science, as well as to increase the number of its cultivators.

"The number of copies ordered to be printed at the last session was less than that of the preceding year, yet the supply to the Institution was the same. Indeed it is a gratifying

"Smithsonian Report," 1859, page 32.

evidence of the public estimation in which the Institution is held, that Congress has been so favorably disposed, even during the depressed condition of the treasury, towards the distribution of this document."

It is difficult to epitomize the contents of these Reports. During the early period of the Institution they were merely reports to Congress, although an extensive appendix to the Report of 1850 was printed. Beginning with the Report for 1854, the general appendix, so called, became a feature. In speaking of this appendix in 1856, Professor Henry said that its object was "to illustrate the operations of the Institution by the reports of lectures and extracts from correspondence, as well as to furnish information of a character suited especially to the meteorological observers and other persons interested in the promotion of knowledge." Until 1865, many important lectures by distinguished scientific men were delivered at the Institution, and their publication was a feature of the Reports. It was also the custom of the Secretary, in these Reports, to summarize the contents of the scientific papers published in the other series, which will be alluded to presently. There were added to the lectures, in each Report, translations of articles relating to science which appeared in foreign journals, descriptions of the organization of important academies abroad, lists of prize questions announced by various learned societies, reports of meteorological observers, biographical sketches of distinguished scientific men recently deceased, and a report of the progress of the science of physics in recent years. Gradually, as the meteorological work ceased to absorb so much of the attention of the Institution, less space was given to that branch of knowledge, and more to North American ethnology and archæology, concerning which there are many contributions in the earlier volumes of the Reports.

As early as 1849, Professor Henry designed that the annual Reports should "give an account of the progress of the different branches of knowledge in every part of the world." He called attention to the fact that the first reports of this sort were due to the Emperor Napoleon, who directed the French Academy "to present him with accounts of the progress of the different branches of knowledge." Reports on special departments of science, which had already been published abroad, were translated into English and printed under this plan; and reports on the state of knowledge in a few fields were especially prepared for the Institution.

The plan, however, of having annual reports especially prepared for the Institution, covering nearly all the branches of science, was not carried out until Professor Baird became Secretary. He had edited for the firm of Harper & Brothers "The Annual Record of Science and Industry," from 1871 to 1878; and in the Report for 1880 there was begun a series entitled "Record of Scientific Progress." The object of the general appendix was there stated to be "To furnish summaries of scientific discovery in particular directions; occasional reports of the investigations made by collaborators of the Institution; memoirs of a general character, or on special topics, whether original and prepared expressly for the purpose, or selected from foreign journals and proceedings; and briefly to present (as fully as space will permit) such papers not published in the 'Smithsonian Contributions' or in the 'Miscellaneous Collections' as may be supposed to be of interest or value to the numerous correspondents of the Institution."

Under this plan, reports of the progress of science were given in astronomy, geology, physics, chemistry, mineralogy, botany, zoölogy, anthropology, meteorology, vulcanology, seismology, North American invertebrate paleontology, and

oriental archæology. It was the practice of Professor Baird, for many years, in his report as Assistant Secretary, to give an account of the natural history explorations of the United States. Since 1889, however, most of these reports of progress have been omitted, though one or two continue to be published, anthropology especially.

Secretary Langley stated in the advertisement to the general appendix of the Report for 1889 that, owing to "the incompleteness of the special record, the discouragement from the increasing delays encountered in the printing of these summaries, the recent multiplication by private enterprise of special books and periodicals devoted to critical summaries," he had decided to temporarily suspend the printing of the Reports, and would revert to what he believed the more acceptable plan, "of publishing yearly papers selected with a principal view to their general scientific interest," rather than to continue these summaries, which were "chiefly of importance to the professional student." This policy has been continued to the present time.

Stress has been laid upon the Reports of the Institution, not because they are the most important publications issued, but for the reason that they are the only volumes the publication of which is based on a direct statement in the organic law of the Institution, and because their large edition has given them the widest circulation.

The most important volumes issued in the name of the Institution, those which have contained the greatest additions to the sum of human knowledge and are most prized among scientific men, are the quarto volumes of "Smithsonian Contributions to Knowledge," thirty-two volumes of which have appeared. This series was foreshadowed in the resolutions appended to the report made January 25, 1847, of the first committee appointed by the Board of Regents for the prepar-

ation of a plan; it being proposed that the Institution procure "original papers containing positive additions to the sum of human knowledge; and that these, together with other suitable papers, be published in 'Transactions of the Institution,' to be entitled 'Smithsonian Contributions to Knowledge,' and to be issued periodically or occasionally, in quarto form, as materials may be obtained."

These "Contributions to Knowledge" combine the two features of the Smithson bequest: they both increase and diffuse knowledge. The program of organization, submitted by Professor Henry in 1847, may still be said to guide the issuing of these volumes. It was proposed to stimulate research by offering rewards for original memoirs on all subjects of investigation:

"1. The memoirs thus obtained to be published in a series of volumes, in a quarto form, and entitled 'Smithsonian Contributions to Knowledge.'

"2. No memoir on subjects of physical science, to be accepted for publication which does not furnish a positive addition to human knowledge, resting on original research; and all unverified speculations to be rejected.

"3. Each memoir presented to the Institution to be submitted for examination to a commission of persons of reputation for learning in the branch to which the memoir pertains, and to be accepted for publication only in case the report of this commission is favorable.

"4. The commission to be chosen by the officers of the Institution, and the name of the author, as far as practicable, concealed, unless a favorable decision be made.

"5. The volumes of the memoirs to be exchanged for the transactions of literary and scientific societies, and copies to be given to all the colleges and principal libraries in this country. One part of the remaining copies may be offered for sale and the other carefully preserved to form complete sets of the work to supply the demand from new institutions.

"6. An abstract, or popular account, of the contents of these memoirs to be given to the public through the annual Report of the Regents to Congress."

In illustration of this portion of the program, Professor Henry wrote:

"The publication of original memoirs and periodical reports, as contemplated by the program, will act as a powerful stimulus on the latent talent of our country, by placing in bold relief the real laborers in the field of original research, while it will afford the best materials for the use of those engaged in the diffusion of knowledge.

"The advantages which will accrue from the plan of publishing the volumes of the 'Smithsonian Contributions to Knowledge,' are various. In the first place, it will serve to render the name of the founder favorably known wherever literature and science are cultivated, and to keep it in continual remembrance with each succeeding volume, as long as knowledge is valued. A single new truth, first given to the world through these volumes, will forever stamp their character as a work of reference. The contributions will thus form the most befitting monument to perpetuate the name of one whose life was devoted to the increase of knowledge, and whose ruling passion, strong in death, prompted the noble bequest intended to facilitate the labors of others in the same pursuit.

"Again, the publication of a series of volumes of original memoirs will afford to the Institution the most ready means of entering into friendly relations and correspondence with all the learned societies in the world, and of enriching its library with their current transactions and proceedings. But perhaps the most important effect of the plan will be that of giving to the world many valuable memoirs, which, on account of the expense of the illustrations, could not be otherwise published. Every one who adds new and important truths to the existing stock of knowledge, must be of necessity, to a certain degree, in advance of his age. Hence the number of readers and purchasers of a work is generally in the inverse

ratio of its intrinsic value; and consequently authors of the highest rank of merit are frequently deterred from giving their productions to the world on account of the pecuniary loss to which the publication would subject them.

"Besides the advantage to the author of having his memoir published in the 'Smithsonian Contributions' free of expense, his labors will be given to the world with the stamp of approval of a commission of learned men; and his merits will be generally made known through the Reports of the Institution.

"There is one proposition of the program which has given rise to much discussion, and which, therefore, requires particular explanation: I allude to that which excludes from the contributions all papers consisting merely of unverified speculations on subjects of physical science. The object of this proposition is to obviate the endless difficulties which would occur in rejecting papers of an unphilosophical character; and though it may in some cases exclude an interesting communication, yet the strict observance of it will be found of so much practical importance that it cannot be dispensed with."[1]

Some objection was made to the publishing of original memoirs by the Institution on the ground that in so doing it was merely performing the duties of a learned society, to which Professor Henry replied "that the learned societies in this country have not the means, except in a very limited degree, of publishing memoirs which require expensive illustrations, much less of assisting to defray the cost of the investigations by which the results have been obtained. The real workingmen in the line of original research hail this part of the plan as a new era in the history of American science. The assistance which the Institution will thus render to original research will occupy the place of the governmental patronage of other countries, and will enable true genius, wherever

[1] "Smithsonian Report," 1847, page 179.

found, to place its productions before the world, free of cost, and in a manner most favorable for securing due attention and proper appreciation."[1]

At the time of the publication of the first volume of the "Contributions to Knowledge" the question of the propriety of the Institution's securing a copyright was raised. Professor Henry decided this question in the negative:

"I had not an opportunity of conferring with the Executive Committee on this point, and was therefore obliged to settle it on my own responsibility. I concluded that it would be in accordance with the spirit of the Institution to decide against the copyright. The knowledge which the Smithsonian Institution may be instrumental in presenting to the world should be free to all who are capable of using it. The republication of our papers ought to be considered as an evidence of their importance, and should be encouraged rather than prohibited."[2]

This policy has always been followed, the only provision being that full credit should be given to the name of Smithson for any extract which is made from these publications. Professor Henry truly said:

"What prouder monument could any man desire than the perpetual association of his name with a series of new truths! This building and all its contents may be destroyed, but the volumes of the Smithsonian Contributions, distributed as they are among a thousand libraries, are as wide-spread and lasting as civilization itself."[3]

Professor C. C. Felton, after returning from Europe, wrote the following letter, which shows how as early as 1854 the publications were appreciated abroad:

"It gave me pleasure to notice the high estimation in which the Smithsonian Institution, under its present manage-

[1] "Smithsonian Report," 1849, page 26. [2] *Ibidem*, page 24. [3] *Ibidem*, 1851, page 10.

ment, is held everywhere in Europe. The volumes published under its auspices have done the highest honor to American science and are considered most valuable contributions to the stock of knowledge among men. They are shown to visitors as among the most creditable publications of the age, and as highly interesting illustrations of the progress of science and the arts in the United States; and the eagerness to possess them is very great among the savants of the Old World. They were shown to me wherever I went, and the commendations bestowed on the civilization of America, as evinced by the excellence of these works, both in matter and form, was deeply gratifying to me."

In the course of the debate in Congress on Senator Choate's resignation as a Regent, Mr. William H. English of Indiana said, in the House of Representatives:

"Original researches have been stimulated, and many valuable memoirs upon scientific subjects published and distributed to all the principal libraries and learned societies in the world. To show conclusively what has already been done in this direction, I will give a list of some of the publications, premising in the language of the secretary of the board, that 'the institution up to this time has scarcely published a single paper the production of which has not been stimulated and assisted, or whose character has not been improved, by the agency of the institution, and, as a whole, they are such as could not have been given to the world without the aid of the Smithsonian bequest.' They are the product of American genius, and have reflected the highest honor on American science.

"These works are distributed gratuitously to most of the incorporated colleges and libraries in the United States, and to the leading literary institutions of other countries. They are not copyrighted, and are sold by the trade at a low rate.

"It may be contended that researches and publications of a character so purely scientific are not calculated directly to diffuse knowledge among the great mass of mankind.

"This is, no doubt, to a certain extent, true, and I shall be glad to see the operations of the institution made as plain and practical as the nature of the subjects will admit; but it should not be forgotten that the grand object of the institution is to add to the sum total of the knowledge *now* existing in the world, and to diffuse it among men, rather than to scatter that more widely which is already accessible in a greater or less degree to all."

While the distinguished naturalist, Professor Louis Agassiz wrote:

"If I am allowed to state, in conclusion, my personal impression respecting the management of the Institution thus far, I would only express my concurrence with the plan of active operations adopted by the Regents, which has led to the publication of a series of volumes equal, in scientific value, to any productions of the same kind issued by learned societies anywhere. The distribution of the 'Smithsonian Contributions to Knowledge' has already carried the name of the Institution to all parts of the civilized world, and conveyed with them such evidence of the intellectual activity of America as challenges everywhere admiration; a result which could hardly be obtained by applying a large part of the resources of the Institution to other purposes."

Of the contents of the "Smithsonian Contributions to Knowledge," it would be impossible to speak here, but it is not too much to say that from the valuable contribution to North American archæology by Squier and Davis, to the contribution on Oceanic Ichthyology, by Goode and Bean, every paper in each volume of this series has carried out the purpose of the organizers of the Institution, to publish only such contributions as would add to the sum of human knowledge. Many of these publications are printed in so expensive a manner, with plates and illustrations, that it is safe to say that their appearance would have been greatly delayed, if not altogether prevented, had not the Smithsonian bequest been

made. A summary of the contents of these memoirs is made annually by the Secretary in his Report to Congress; and an "appreciation" of their importance for the advancement of knowledge and of the new truths they contain is found in the various chapters of the second part of this work. All of the volumes of this series have been issued at the expense of the Smithson bequest, without any assistance from Congress, or from any other fund.

The same statement applies to the third Smithsonian series, which is an octavo series, known as the "Smithsonian Miscellaneous Collections," now consisting of thirty-five complete volumes with three others in course of publication, making in all thirty-eight. This series, which "is intended to embrace all the publications issued directly in octavo form," was "designed to contain reports on the present state of our knowledge of particular branches of science; instructions for collecting and digesting facts and materials for research; lists and synopses of species of the organic and inorganic world; museum catalogues; reports of explorations; aids to bibliographical investigations, etc., generally prepared at the express request of the Institution and at its expense." In the "Smithsonian Miscellaneous Collections," as well as in the "Smithsonian Contributions to Knowledge," each article is separately paged and indexed, and the actual date of its publication is given on the special title-page.

A considerable proportion of this series is devoted to scientific bibliography. When separate publications for the Museum were first established, it was the practice to reprint the "Proceedings" and "Bulletin" in the "Smithsonian Miscellaneous Collections." It was also the custom, when the scientific societies of Washington were in their infancy, for the Institution to publish the proceedings of these societies, more especially the Philosophical, Anthropological, and Biological, the establishment of all of which societies, it may be said, was directly

due to the initiative and encouragement of the members of the staff of the Smithsonian Institution.

A very interesting suggestion was made in Congress in 1851, by Mr. Thompson, of Mississippi. When the bill containing the appropriation of money to purchase books for the Library of Congress was under consideration, he proposed an amendment requiring that the plates and engravings of the report of the Wilkes Exploring Expedition, which had been made at the expense of the United States, should be delivered to the Smithsonian Institution for the issuing of a new edition. All students of science will deplore the fact that this important amendment was lost.

In addition to these three series, and excepting the publications of the bureaus under the direction of the Smithsonian Institution, it has issued certain other publications which may be, for want of any particular designation, called "Special Publications." One of these is a quarto volume of almost twelve hundred pages, entitled "The Results of Meteorological Observations made under the Direction of the United States Patent Office and the Smithsonian Institution," and published by the government in 1861 as a general report of the Commissioner of Patents and the Secretary of the Smithsonian Institution. The memoirs of Professor James P. Espy on Meteorology, one of which was embodied in a message to the President of the United States, the others being reports made to the Secretary of the Navy, were all prepared as a part of the Smithsonian meteorological work, the staff being the observers attached to the Institution.

The first publication of the Institution was entitled "Hints on Public Architecture," being really a careful description of the proposed building of the Institution, by Robert Dale Owen, chairman of the building committee. A half dozen detached papers which have never been included in any of

the regular series were also issued. The volume containing the report on the exploration of the Colorado River of the West and its tributaries, by Major J. W. Powell, was prepared under the direction of the Smithsonian Institution and printed by order of Congress upon being submitted to that body by the Secretary. Recently the Institution issued, as a separate volume, not to be placed in any of its series, the "Diary of a Journey through Mongolia and Tibet," by William Woodville Rockhill, First Assistant Secretary of State, who undertook an expedition through these countries with the aid of the Institution.

The Institution has also, in several cases, indirectly aided the publication of valuable scientific memoirs. The most notable of these was the series known as "The Library of American Linguistics," now extremely rare and costly, edited by John G. Shea. The manuscript of some of this series had actually been in the possession of the Institution with a view to publication. Mr. Shea, however, presented a memoir to the Secretary, expressing a desire to publish them all in one series, and asking for the aid of the Institution. They were referred to a commission, of whom E. B. O'Callahan, the well known bibliographer, Jared Sparks, George Gibbs, and Peter Force were members. This commission recommended to the Smithsonian Institution that "a subscription which will insure the continuance of these series will be eminently within the scope of the foundation, by preserving a number of rapidly perishing monuments of human knowledge, and securing to posterity, in the languages of the native tribes, the surest clue to their origin and affinities." All of these volumes were printed at the Cramoisy Press, in New York, "under the auspices of the Smithsonian Institution." To the "Grammar of the Mutsun Language" the following "advertisement" was prefixed:

"Material for this work was forwarded to the Smithsonian Institution, with a number of other Indian vocabularies. . . . The intention was to publish it with other manuscripts in the course of several years,—as a part of the miscellaneous collections of the Institution, but it was afterwards concluded that more service could be done in the way of advancing knowledge,—with the small appropriation which could be devoted to this purpose, by transferring the work to Mr. John G. Shea of New York, to be published as a part of his interesting series of American Linguistics. It is accordingly presented to the student of ethnology by Mr. Shea, under the auspices and in part at the expense of the Smithsonian Institution."

Since 1881, the National Museum has made separate annual Reports. From 1881 to 1883 they were embodied in the Smithsonian Report. Since 1884 they have formed a second volume of the Smithsonian Report, and consist of an account of the administrative work of the year, with an appendix containing papers by members of the staff concerning the collections, or by collaborators of the Institution, based upon these collections. Some of these publications are large and valuable documents, containing more than one thousand pages and many illustrations.

Since 1878 the Museum has issued an octavo series entitled "Proceedings of the United States National Museum," the nineteenth volume of which is now in course of publication, their character being indicated by the following statement:

"Many of the objects gathered are of a novel and important character, and serve to throw a new light upon the study of nature and of man.

"The importance to science of prompt publication of descriptions of this material led to the establishment of the present series, . . . the distinguishing particularity of which is that the articles are published in pamphlet form as fast as

completed and in advance of the bound volume. . . . The articles in this series consists: First, of papers prepared by the scientific corps of the National Museum; secondly, of papers by others, founded upon the collections in the National Museum; and, finally, of facts and memoranda from the correspondence of the Smithsonian Institution."

The third series of the Museum, also published in octavo size, is known as the "Bulletin of the National Museum," forty-nine numbers of which have now been issued. The publication of the "Bulletin" was begun in 1875, constituting the "elaborate papers based upon the collections of the Museum." A number of these Bulletins contain scientific bibliographies of American naturalists.

The Museum has also issued forty-six circulars of instructions, and four handsomely illustrated quarto volumes, two of which are devoted to the "Life Histories of North American Birds," and the others to a description of the "Deep Sea Fishes of the North Atlantic Basin."

The Bureau of American Ethnology, which is also under the direction of the Smithsonian Institution, has issued the following series: first, annual reports, making now thirteen royal octavo volumes, devoted to North American ethnology; second, twenty-four bulletins, in octavo, special monographs, among the most valuable being the linguistic bibliographies of Pilling; third, a quarto series of eight volumes, entitled "Contributions to North American Ethnology," being the results of the geographical and geological survey of the Rocky Mountain Region, conducted under the immediate direction of Major Powell, upon the initiative, and with the aid of the Smithsonian Institution; fourth, a series of four "Introductions," in quarto form, issued in a very small edition, and intended only for the use of the collaborators of the Bureau; and, finally, four miscellaneous publications, three of which

were similarly issued for the collaborators of the Bureau, the other being a map of North American linguistic stocks.

In 1889 the American Historical Association was incorporated by act of Congress, with the proviso that the association should report annually to the Secretary of the Smithsonian Institution concerning its proceedings and the condition of historical study in America. Under this authority, seven octavo volumes of historical papers and historical bibliography have been issued.

All of these publications are distributed freely. The Reports of the Institution and Museum are sent to all the principal libraries in America, and in foreign lands, and to the collaborators and friends of the Institution and of the Museum throughout the world. The same is true, in a lesser degree, owing to the fact that the edition is limited, of the "Proceedings" and "Bulletin" of the Museum, which are sent to all important American colleges, to all State libraries, to all State historical societies, and to a specially selected list of scientific men. The publications of the Bureau of American Ethnology are distributed in like manner through the Director of the Bureau. Owing to the expensive nature of the "Smithsonian Contributions to Knowledge" and the "Smithsonian Miscellaneous Collections," it has never been possible to publish a large edition of these series; so that their distribution has been limited to 1000 libraries, about 650 in the United States, and the remainder in foreign lands; a small edition being reserved for the collaborators of the Institution.

It will thus be seen that the publications issued by the Smithsonian Institution and under its direction, from its own funds and with the assistance of the government, form in themselves a library which records the progress and illustrates the advance of knowledge in every field of human activity during the last fifty years.

BIOGRAPHICAL SKETCH OF GEORGE BROWN GOODE

BY DAVID STARR JORDAN,

President of Leland Stanford Junior University.

THE untimely death of George Brown Goode has left a great break in the ranks of the scientific men of America. One of the most accurate and devoted of students, the ablest exponent of museum methods, a man of the most exalted personal character, Doctor Goode occupied a unique position in the development of American science.

George Brown Goode was born in New Albany, Indiana, on February 13, 1851, and died of pneumonia at his home on Lanier Heights in Washington City on September 6, 1896. According to Doctor Marcus Benjamin, to whom I am indebted for many of the details of this sketch:

"Doctor Goode was of Colonial descent. His family lived in Virginia, and he traced with pride his paternal line to John Goode, who came to that colony prior to 1660, and settled four miles from the present site of Richmond, on an estate which he named 'Whitby.' John Goode was one of the advisers of Bacon in 1676, in the first armed uprising of the Americans against the oppression of royal authority. On

his mother's side he was descended from Jasper Crane, who came to New England before 1630, and afterwards settled near the present site of Newark, New Jersey. Doctor Goode's father was Francis Collier Goode, who married, in 1850, Sarah Woodruff Crane, and their distinguished son was born at the home of his maternal grandfather."

In 1857 Doctor Goode's parents moved to Amenia, in New York State, where the boy passed his early youth, and where he was prepared for college. In due time young Goode was matriculated in Wesleyan University in Middletown, Connecticut, where he graduated in 1870, at the too early age of nineteen.

The fixed curriculum of the college gave him little opportunity for the studies in which he was chiefly interested, and his standing in the conventional branches on which the higher education was then supposed to depend was not unusually high. He was, however, regarded as "a man exceptionally promising for work" in natural history.

Doctor Goode spent part of the year of 1870 in graduate work in Harvard, and there fell under the stimulating influence of the greatest of teachers of science, Louis Agassiz. Before the year was over he was recalled to Middletown to take charge of the Museum of Natural Science then just erected by Orange Judd. His work in Judd Hall was a prelude to his reorganization of the National Museum in Washington, an institution which will always show in its classification and arrangement the traces of his master hand.

In 1872 he first met Professor Baird in Eastport, Maine, and in 1873, while at the meeting of the American Association for the Advancement of Science, in Portland, Maine, he renewed this acquaintance. Professor Baird, with his characteristic insight into the ambitions and possibilities of promising young men,—one of his notable qualities,—invited Doctor

Goode to aid in the work of the newly organized Fish Commission. At that time Professor Baird was Assistant Secretary of the Smithsonian Institution in charge of the National Museum, and also United States Fish Commissioner. The organizations were managed in similar fashion and all their activities directed to the same high ends. Very soon Doctor Goode was brought into the service of them both. In the summer he was employed by the Fish Commission in investigations and explorations along the Atlantic Coast. In the winter he divided his time between Wesleyan University and the National Museum, until the former institution was reluctantly compelled in 1877 wholly to give him up. Till that date his only compensation for work done in Washington was found in duplicate specimens of fishes and other animals, which in turn were presented by him to the museum in Middletown.

In 1887 he became Assistant Secretary of the Smithsonian Institution in charge of the National Museum. On the death of Professor Baird he became for a time United States Fish Commissioner, holding the office without pay until a change in the law permitted the appointment of a separate salaried head. In his later years Mr. Goode devoted his whole energies to museum administration, a kind of work for which no one in the world has ever shown greater aptitude. Two important publications,[1] "Museums of the Future" and "Principles of Museum Administration," admirably embody his views and experiences in this regard. His appreciation

[1] "The Museums of the Future." Report of the United States National Museum, 1889, page 427. This paper was originally delivered as a lecture before the Brooklyn Institute, on February 28, 1889. "The Principles of Museum Administration." Annual Report of the Museums Association, 1895, reprinted as an octavo pamphlet of 73 pages.

In addition to the foregoing, Doctor Goode published the following papers on Museum Administration: "Museum History and Museums of History," "Papers of the American Historical Association," Volume II, 1889, page 251 (495); "Genesis of the National Museum." Report of the United States National Museum, 1891, page 273. In this connection it is also proper to mention his "Annual Reports" as director of the United States National Museum, beginning with the year 1881.

of the importance of such work is characteristically shown in his dedication of an interesting genus of deep-sea fishes to "Ulysses Aldrovandi, of Bologna, the founder of the first natural history museum."

His interest in museum administration caused a large amount of "exposition work" to be entrusted to his hands. An exposition is a temporary museum with a distinctly educational purpose. It can be made a mere public fair on a large scale, or it can be made a source of public education. In Doctor Goode's hands an exhibition of material was always made to teach some lesson. He had charge, under Professor Baird, of the Smithsonian exhibits in the Centennial Exhibition of 1876, in Philadelphia. He served as United States Commissioner in the Fisheries Exhibition held in Berlin in 1880, and in London in 1883. He was a member of the Board of Management of the government exhibit in the World's Columbian Exposition of 1893, and also prepared the general plan of classification adopted for the Exposition.[1] He was equally active in minor expositions held in New Orleans, Cincinnati, Louisville, Atlanta, and elsewhere. He was also concerned in the Columbian Historical Exposition held in Madrid 1892–93, and for part of the time acted as Commissioner-General for the United States.[2] His services in that connection were recognized by the conferment of the order of Isabella the Catholic, with the rank of Commander. From the Fisheries Exposition in London he received a medal in honor of his services to the science of ichthyology.

Doctor Goode was always deeply interested in the historical and biographical side of science, and in the personality,

[1] "First Draft of a System of Classification for the World's Columbian Exposition," submitted to the President of the World's Columbian Commission. Report of the United States National Museum, 1891, page 649.

[2] "The Report of the United States Commission to the Columbian Historical Exposition at Madrid, 1892–93, with Special Papers," Washington, 1895, was prepared under Doctor Goode's direction.

the hopes, and the sorrows of those who preceded him in the study of fishes and other animals. This showed itself in sympathetic sketches of those who had to do with the beginnings of American science as well as with the dedication of new genera to those who had done honor to themselves by honest work in times when good work was not easy, and was not valued by the world. Among those thus recognized by him was Thomas Harriott, of Roanoke (an associate of Raleigh), who published the first work in English on American natural history.

His interest in the biographical side of science led him to the scientific side of biography. From boyhood he was interested in genealogy. His own family records were published by him under the title of "Virginia Cousins."[1] This has been regarded as a model genealogical monograph. Doctor Goode believed that the way to do any piece of work is to do it thoroughly. Nothing crude or incoherent ever left his pen.

Doctor Goode was one of the founders of the American Historical Association, and a member of its executive council from 1889 till his death. He contributed to its proceedings in 1889 his valuable paper on the "Origin of the National Scientific and Educational Institutions of the United States." He was also a member of the "Southern Historical Society," organized in 1896. Much of his leisure during his last two summers was given to the preparation of the material that is used in the present volume, which was his project, and which when published will be a monument to his knowledge of science in this country during the first half-century of the existence of the Smithsonian Institution.

[1] "Virginia Cousins. A study of the ancestry and posterity of John Goode, of Whitby, a Virginia colonist of the Seventeenth Century, with notes upon related families. A key to Southern Genealogy, and a history of the English surname Gode, Goud, Goode, or Good, from 1148 to 1887. By G. Brown Goode, with a preface by R. A. Brock, secretary of the Virginia and Southern Historical Societies." Richmond, Virginia: J. W. Randolph & English, MDCCCLXXXVII. [Quarto, XXXVI + 526 pages, 54 plates.]

Doctor Goode was one of the founders of the Society of the Sons of the American Revolution in the District of Columbia, and after filling various offices was, in 1894, made President. He was also Vice-President of the Society of the Sons of the Revolution, and Lieutenant-Governor of the Society of Colonial Wars in the District of Columbia.

He was very prominent in the organization and conduct of scientific societies, which he regarded as valuable agencies in the spread of scientific knowledge. He had been President both of the Philosophical Society and the Biological Society of Washington. He was elected to the American Association for the Advancement of Science in 1873, and to the National Academy of Sciences in 1888. He was also a member of the Zoölogical Society of London. His work in science was recognized in 1886 by the degree of Ph.D. from the University of Indiana, his native State. It was the fortune of the present writer to accept as a thesis from him the "Catalogue of the Fishes of the Bermudas," and to move the granting of this degree. His relation to general culture and executive work was recognized by Wesleyan University by the degree of LL. D. conferred in 1888.

The writer first met Doctor Goode in 1874, while he was engaged in work for the United States Fish Commission in Noank, Connecticut. He was then a young man of scholarly appearance, winning manners, and a very enthusiastic student of fishes. In body he was of medium height, rather slender, and very active. His countenance was intellectual, and he seemed always to have a very definite idea of what he wished to do.

Our first meeting was in connection with an effort on his part to find the difference between the two genera of fishes called Ceratacanthus and Alutera. At this time I was greatly impressed with the accuracy and neatness of his

work, and especially with his love of what may be called the literary side of science,— a side too often neglected by scientific men. He detested an inaccuracy, a misspelled name, or a slovenly record, as he would have despised any other vice. Indeed, in all his work and relations moral purity and scientific accuracy were one and the same thing. He had inherited or acquired "the Puritan conscience," and applied it not only to lapses of personal integrity, but to weaknesses and slovenliness of all sorts. Hence he became in Washington not only a power in scientific matters, but a source of moral strength to the community. His influence is felt in the Museum not only in the wisdom of its organization, but in the personal character of its body of curators. The irresponsible life of Bohemia is not favorable to good work in science, and the men he chose as associates belong to another order.

As to Doctor Goode's moral influence and youthful characteristics, the following extracts from a private letter of Professor Otis T. Mason, Curator of Ethnology in the United States National Museum, will be found valuable:

"Two characteristics of the man fixed themselves upon my mind indelibly: I found him to be intensely conscientious, and I could see that he was a young man who not only wished to live a correct life himself, but abhorred the association of evil men.

"Another characteristic which forced itself upon me was his devotion to the museum side of scientific investigation. He wrote a beautiful hand, and on one occasion he told me that it was just as much the duty of a scientific investigator to write a good hand and spell his names correctly, so that there would be no mistake in the label, as it was for him to make his investigations accurately. You will find, if you will look over some of the specimens which he marked at that time, beautiful numerals, clear and distinct, so that there is no mistaking one from the other.

"Again, I discovered the pedagogic feeling to be very strong in him, and the interests of the public no less than of the investigator were constantly before his mind. Indeed, there was nothing about Doctor Goode in his admirable management of the Museum in later years that did not make its appearance to some extent when he had the work to do with his own hands. The germ of our present discipline manifested itself in the discipline which he exerted over his own conduct when he was junior assistant instead of director.

"About the time that Doctor Goode came to the Museum, I undertook to arrange the ethnological collections. I can remember the delight which it gave him to consider a classification in which the activities of mankind were divided into genera and species subject to the laws of natural history, of evolution, and geographic surroundings. The development of the Department of Arts and Industries has been the result of these early studies."

Doctor Goode had a wonderful power of analyzing the relations or contents of any group of activities, or of any objects of study. This showed itself notably in his two catalogues[1] of collections illustrating the animal resources of the United States. These catalogues were written with reference to the arrangement of material for the exhibits of the Smithsonian Institution and the United States Fish Commission at the Centennial Exhibition at Philadelphia. "It was," says Doctor Gill, in his admirable biographical sketch,[2] "the ability that was manifested in these catalogues and the work incidental to their preparation that especially arrested the atten-

1 "Classification of the Collection to Illustrate the Animal Resources of the United States. A list of substances derived from the animal kingdom, with synopsis of the useful and injurious animals and a classification of the methods of capture and utilization." Washington, 1876. "Bulletin Number 6, United States National Museum."

"Catalogue of the Collection to Illustrate the Animal Resources and the Fisheries of the United States, exhibited at Philadelphia in 1876 by the Smithsonian Institution and the United States Fish Commission, and forming a part of the United States National Museum." Washington, 1879. "Bulletin No. 14, United States National Museum."

2 *Science*, New Series, Volume IV, 1896, page 665.

tion of Professor Baird and marked the author as one well adapted for the direction of a great museum. For signal success in such direction special qualifications are requisite. Only some of them are a mind well trained in analytical as well as synthetic methods, an artistic sense, critical ability, and multifarious knowledge, but above all the knowledge of men and how to deal with them. Perhaps no one has ever combined, in more harmonious proportions, such qualifications than G. Brown Goode. In him the National Museum of the United States, and the world at large have lost one of the greatest of museum administrators."

The most striking character of Doctor Goode's scientific papers was perhaps their scholarly accuracy and good taste. He never wrote a paper carelessly. He was never engaged in any controversy, and he rarely made a statement which had later to be withdrawn. Yet no one was more ready to acknowledge an error, if one were made, and none showed greater willingness to recognize the good work of others. The literature even of the most out-of-the-way branch of zoölogical research had a great fascination for him, and he found in bibliography and in the records of the past workers in science a charm scarcely inferior to that of original observation and research. In his later years administrative duties occupied more and more of his time, restricting the opportunities for his own studies. He seemed, however, to have as great delight in the encouragement he could give to the work of others.

The great work of his life—"Oceanic Ichthyology"—was, however, written during the period of his directorship of the National Museum, and was published but a month before his death. Almost simultaneous with this were other important publications of the National Museum, which were his also in a sense, for they would never have been undertaken

except for his urgent wish and encouragement. If a personal word may be pardoned, "The Fishes of North and Middle America," which closely followed "Oceanic Ichthyology," would never have been written except for my friend's repeated insistence and generous help.

In the earlier days of the scientific activities of the Smithsonian Institution, there was scarcely a young naturalist of serious purposes in the land who had not in some way received help and encouragement from Professor Baird. With equally unselfish effectiveness and lack of ostentation, Doctor Goode was also in different ways a source of aid and inspiration to all of his scientific contemporaries. The influence of the National Museum for good in the United States has been great in a degree far out of proportion to the sums of money it has had to expend. It has not been a Washington institution, but its influence has been national.

The first recorded scientific paper of Doctor Goode is a note[1] on the occurrence of the bill-fish in fresh water in the Connecticut River. The next is a critical discussion of the answers to the question "Do snakes swallow their young?" In this paper he shows that there is good reason to believe that in certain viviparous snakes, the young seek refuge in the stomach of the mother when frightened, and that they come out when the reason for their retreat has passed.

The first of the many technical and descriptive papers on fishes was the "Catalogue of the Fishes of the Bermudas,"[2] published in 1876. This is a model record of field observations and is one of the best of local catalogues. Doctor Goode retained his interest in this outpost of the great West Indian fauna, and from time to time recorded the various additions made to his first Bermudan catalogue.

[1] *The American Naturalist,* Volume v, page 487.

[2] "Bulletin Number 5, United States National Museum."

After this followed a large number of papers on fishes, chiefly descriptions of species or monographs of groups. The descriptive papers were nearly all written in association with his excellent friend, Doctor Tarleton H. Bean, then Curator of Fishes in the National Museum.

In monographic work Doctor Goode took the deepest interest, and he delighted especially in the collection of historic data concerning groups of species. The quaint or poetical features of such work were never overlooked by him. Notable among these monographs are those of the Menhaden, the Trunk-fishes, and the Sword-fishes.

The economic side of science also interested him more and more. That scientific knowledge could add to human wealth or comfort was no reproach in his eyes. In his notable monograph of the Menhaden,[1] the economic value as food or manure of this plebeian fish received the careful attention which he had given to the problems of pure science.

Doctor Goode's power in organizing and coördinating practical investigations was shown in his monumental work[2] on the American fisheries for the tenth Census in 1880. The preparation of the record of the fisheries and associated aquatic industries was placed in his hands by Francis A. Walker, Superintendent of the Census. Under Doctor Goode's direction skilled investigators were sent to every part of the coast and inland waters of the country. A general survey of the aquatic resources, actual and possible, of the United States was attempted, and statistics of every kind were secured on a grand scale. His directions to field agents, still unpublished, were models in their way, and no

1 "The Natural and Economical History of the American Menhaden." Contained in Appendix A of Part 5 of "Report of United States Commission of Fish and Fisheries," for 1877, Washington, 1879.

2 "The Fisheries and Fishery Industry of the United States." Prepared through the coöperation of the Commissioner of Fisheries and the Superintendent of the Tenth Census, Washington, 1884.

possible source of information was neglected by him. The results of all these special reports were received and condensed by Doctor Goode into seven large quarto volumes, with a great number of plates. The first section of the "Natural History of Aquatic Animals" was a contribution of the greatest value. Although the information it gives was obtained from many sources, through various hands, it was so coördinated and unified that it forms a harmonious treatise, while at the same time the individual helpers are fully recognized.

All these works, according to Doctor Goode, belong to Lamb's category of "books which are not books." His expressed ambition to write a book not of this kind, one that people would buy and read, found actuality at last. In 1888 appeared his "American Fishes," a popular treatise on the game and food fishes of North America,[1] a work without a rival because of its readableness, its scientific accuracy, and the excellence of its text. The work is notable for its quotations, which include almost all the bright things which have been said about fishes by poets and anglers and philosophers from the time of Aristotle to that of Izaak Walton and Thoreau. In this book more than in any other Doctor Goode shows himself a literary artist. The love of fine expression which might have made a poet of him was developed rather in the collection of the bright words and charming verse of others than in the production of poetry of his own. While limiting himself in this volume to fragments of prose and verse in praise of fishes and their haunts, it is evident that these treasures were brought forth from a mind well stored with riches of many fields of literature.

[1] "American Fishes." A popular treatise upon the Game and Food Fishes of North America, with especial reference to habits and methods of capture. With numerous illustrations including a colored frontispiece. New York, 1888.

The most important of Doctor Goode's scientific studies have relation to the fishes of the deep sea. In all this work he was associated with Doctor Bean, and the studies of many years were brought together in the splendid summary of all that is known of the fishes of the ocean depths and the open sea. This forms two large quarto volumes,— text and atlas, — published shortly before Doctor Goode's death under the name of "Oceanic Ichthyology."[1] The exploration of the deep sea has been mostly undertaken within the last twenty years. The monumental work of the *Challenger*, under the direction of the British government, has laid the foundation of our knowledge of its fauna. The *Travailleur* and the *Talisman*, under French auspices, and the *Investigator*, under direction of the government of India, have added greatly to our stock of information. The great work of Goode and Bean includes the results of these and of various minor expeditions, while through the collections of the *Albatross*, the *Blake* and the *Fish Hawk* they have made great additions to the knowledge of the subject. Indeed, the work of the *Albatross* in deep-sea exploration is second in importance only to that of the *Challenger*. In the work of the exact discrimination of genera and species, this work shows a distinct advance over all other treatises on the abyssal fishes. The fact of the existence of definite though large faunal areas in the deep seas was first recognized by Doctor Goode, and has been carefully worked out in a memoir still unpublished. In "Oceanic Ichthyology" and the minor papers preceding it, Goode and Bean have made known numerous new forms of deep-sea fishes, naming in the last-mentioned work alone one hundred and fifty-six

[1] "Oceanic Ichthyology. A treatise on the Deep-Sea and Pelagic Fishes of the World, based chiefly upon the collections made by the steamers *Blake*, *Albatross*, and *Fish Hawk* in the Northwestern Atlantic, with an Atlas containing 417 figures." 2 volumes, I., 553 pages, II., 123 plates, Washington, 1895.

new species and fifty-five new genera belonging to the abyssal fauna of the Atlantic.

But Doctor Goode's interest and sympathy were not confined to the branch of science in which he was a master. He had a broad acquaintance with general natural history, with crustaceans, reptiles, birds, and mammals. On all these groups he published occasional notes. Doctor Gill tells us that "the flowering plants also enlisted much of his attention, and his excursions into the fields and woods were enlivened by a knowledge of the objects he met with." "Anthropology," Doctor Gill continues, "naturally secured a due proportion of his regards, and, indeed, his catalogues truly embraced the outlines of a system of the science."

Doctor Goode was, as already stated, always very greatly interested in bibliography. No work to him was ever tedious, if it were possible to make it accurate. He had well under way the catalogues of the writings of many American naturalists, among others those of Doctor Gill and the present writer. Two of these are already published under the Smithsonian Institution as Bulletins of the United States National Museum, being numbers of a series of "Bibliographies of American Naturalists." The first contains the writings of Spencer Fullerton Baird (1883). Another is devoted to Charles Girard (1891), who was an associate of Professor Baird, though for his later years resident in Paris. A bibliography of the English ornithologist, Philip Lutley Sclater (1896), has been issued since Doctor Goode's death.

Doctor Gill tells us that "a gigantic work in the same line had been projected by him and most of the material collected; it was no less than a complete bibliography of Ichthyology, including the names of all genera and species published as new. Whether this can be completed by another hand remains to be seen. While the work is a great desid-

eratum very few would be willing to undertake it or even arrange the matter already collected for publication. In no way may Ichthyology, at least, more feel the loss of Goode than in the loss of the complete bibliography."

Doctor Goode was married on November 27, 1877, to Sarah Lamson Ford Judd, daughter of Orange Judd, the well-known publisher, and the founder of Orange Judd Hall at Wesleyan University in which Doctor Goode's career as a museum administrator began. The married life of Doctor and Mrs. Goode was a very happy one. The wife and four children are still living.

As to the personal qualities of Doctor Goode, I cannot do better than to quote the following words of two of his warmest friends. Doctor S. P. Langley wrote: "I have never known a more perfectly true, sincere and loyal character than Doctor Goode's; or a man who with a better judgment of other men, or greater ability in moulding their purposes to his own, used these powers to such uniformly disinterested ends, so that he could maintain the discipline of a great establishment like the National Museum, while retaining the personal affection of every subordinate." "His disposition," says Doctor Theodore Gill, "was a bright and sunny one, and he ingratiated himself in the affections of his friends in a marked degree. He had a hearty way of meeting intimates, and a caressing cast of the arm over the shoulder of such an one often followed sympathetic intercourse. But in spite of his gentleness, firmness and vigor in action became manifest when occasion called for them."

Of all American naturalists Doctor Goode was the most methodical, the most conscientious and the most artistic. And of them all no one was more beloved by his fellows. Neither in his life nor after his death was ever an unkind word said of him.

APPRECIATIONS OF THE WORK OF THE SMITHSONIAN INSTITUTION

PHYSICS

BY THOMAS CORWIN MENDENHALL,

President of the Worcester Polytechnic Institute

THE half-century during which the Smithsonian Institution has existed will always be distinguished by reason of the extraordinary development of the physical sciences which has occurred during that period. It is undoubtedly true that at no other time in the history of the world have the conditions of life been so seriously affected by the applications of scientific discovery. These are years that have witnessed the perfected use of steam and steel, at sea and on land, revolutionizing the methods of transportation of men and merchandise. During the passage of these years the various phenomena related to electricity have been magnified, controlled, and directed in the interests of man, until the results are little short of marvelous; and thus, by the use of new forms of energy and material hitherto unavailable, all nations and races are suddenly brought into relations with each other of such unavoidable intimacy as to give rise to an entirely new set of social and economical problems, the solution of which will demand the best efforts of the present and future generations. In justice to the early half of the nine-

teenth century, and to the centuries that have preceded it, it must be admitted that these great and significant changes are to be attributed to a remarkable and successful activity along the lines of applied science, rather than to a relatively greater number of scientific discoveries of the first class. Indeed, the present is the era of applied science, the foundations of which were, in general, laid in the scientific discovery of fifty and more years ago.

In view of this fact, it might be assumed that the Smithsonian Institution, whose function it is, and has been, rather to restrict its interest to what is generally known as "pure" science (believing that applied science will not lack support from other sources), has not been an important factor in the establishment of the dominion of physical science which characterizes the close of the present century. Such a conclusion, however, would be quite out of harmony with the facts, an examination of which will show that the name and fame of the Institution will be forever inseparably linked with some of the most important conquests of original research or ingenious and far-reaching practical applications of scientific principles for which the period is famous.

There might naturally have been created, in the early history of the Institution, through its first Secretary, who more than any one else, or perhaps all others, determined its character and plan of organization, and who was himself one of the most distinguished physicists of his time, a noticeable discrimination in favor of physical science. Indeed, there are occasional sentences in his early reports which show how strongly his thoughts tended in that direction. In his first report to the Board of Regents, submitted December 8, 1847, in speaking of the fact that many important suggestions as to the organization of the Institution had been offered by different persons independently of each other, he says: "Indeed

the general plan of the increase and diffusion of knowledge, as adopted by the Board, is such as would naturally rise in the mind of any person conversant with the history of physical science and with the means usually employed for its extension and diffusion." But this unconscious leaning toward that department of human knowledge with which he was most conversant, and in which he had already won distinction, did not influence him in the slightest degree in drawing up the program of organization which he submitted to the Regents on the same date as above, or in his administrative execution of that program during the many years of his secretaryship. In the introduction to the plan submitted to, and approved by, the Regents, he says: "The will makes no restriction in favor of any particular kind of knowledge; hence all branches are entitled to a share of attention." It is to this broad and catholic spirit by which Joseph Henry was controlled that the world is indebted for an instrumentality for the general good which has no likeness among all the many scientific, educational, or charitable establishments of the Old World or the New.

In attempting to review the operations of the Smithsonian Institution in any special field, it is of first importance that the above considerations should be kept in mind. The will of the man who had made the peculiar bequest was law to the man who, most fortunately, had been selected as its first administrator. The Institution was to have two distinct, but closely-related, functions: to increase knowledge and to diffuse it among men. Henry proposed to increase knowledge by stimulating original research through suitable rewards and pecuniary assistance, where it was necessary or desirable; he would diffuse it by the publication of periodical reports and occasional monographs or separate treatises. But all of this was to be controlled by the general and most

pregnant principle that *the Institution should do nothing which can be equally well done through other agencies.* It is to the adoption of this rule, the farsighted wisdom of which cannot be questioned, that we must attribute an apparent lack of continuity in its operations in physical science, which is probably equally noticeable elsewhere; for its policy has been to do what could not be done otherwise; to help only when help was absolutely necessary.

In taking account of the contributions to the various departments of physics which the coöperation of the Smithsonian Institution has made possible, or with which it has been conspicuously related or associated, one must necessarily begin with the splendid discoveries of its first distinguished head. It is true that many of the most important of these were actually made during that eventful period of his life which preceded his appointment as Secretary of the Institution, but it is also true that many of them did not find their full development until after that date, and, indeed, it is only during the last decade that some of the most important have received recognition at their proper value.

Henry's contributions to physics covered a wide range, but they are most numerous along the line of electricity, magnetism, acoustics, and meteorology. They were originally published, for the most part, in the earlier volumes of the *American Journal of Science*, but much of his later work was, until recently, to be found only by searching the pages of various government publications, or in the transactions of several of the learned societies. In 1886, however, by direction of the Regents of the Institution, the then Secretary, Professor Baird, published a collection of his "Scientific Writings" in two large and handsome volumes, which are among the most important of the Smithsonian contributions to physics. As already stated, within a few years there has

been a great revival of interest in Henry's work, and the appearance of these volumes was most timely.

Most physicists are well informed concerning his discoveries in electricity and magnetism especially, but the interests of the general reader demand at least brief reference to them in this place.

The work of an able, successful man is so mixed up with his personality that it is often difficult to properly describe the former without some reference to the latter. Of Henry the man this is not the appropriate place to speak at length, but his relation to contemporary discovery cannot be fully understood without remembering that his leading personal characteristics were modesty, great patience, untiring industry, and an attention to the minutest detail which is rarely found among men of his class in intellectual power. He was conscientious, almost to excess, in the performance of any duty that came to him. He was educated in the Albany Academy, in which, almost immediately after graduation, he was employed as a teacher. By one of his pupils of that time he is referred to as one "who rose with the sun to instruct his pupil, eager after knowledge," and as "giving his heart and soul to the duties of the school." Notwithstanding the fact that his duties demanded nearly his entire time during the daylight hours, he found leisure to begin and carry on a series of investigations that were destined to render both him and the otherwise little-known Academy famous for all time. His first important work was the development and perfecting of the electro-magnet. With this now commonplace but most important electrical device three names will always be associated. Shortly after the announcement of Oersted's brilliant discovery, which furnished the first connecting link between electricity and magnetism, Arago had announced the interesting fact that if rods of steel or

iron were placed in a glass tube around which a wire was coiled so that the adjacent rings did not touch each other, they would become magnetic on the passage of a current of electricity through the wire. Thus Oersted's discovery, that an electrical current would *influence* a magnet, was supplemented by Arago's, that it would also *produce* a magnet. Three or four years later another notable step in advance was made by Sturgeon, in England, who produced for the first time what has since been known as an "electro-magnet." He bent a bar of soft iron into the shape of a horseshoe, thus bringing the poles into the same plane for greater convenience; and he dispensed with the glass tube used by Arago by varnishing his iron core, thus insulating the coils of naked wire, which he wound in a spiral about it. But the most powerful electro-magnets made by Sturgeon's method were insignificant compared with what Henry was able to produce a few years later. Instead of varnishing the iron core and using naked wire, he insulated the copper-wire itself by covering it with silk, and this enabled him to coil the wire closely and to make two or more layers about the core. This had the effect of enormously increasing the strength of the magnets produced, and Henry at once recognized the importance of the discovery. But he carried the investigation much further, examining into the relation of the battery to the magnet, developing two forms of the latter, which he called "quantity" and "intensity" magnets, and by the aid of the latter succeeded in making visible and audible signals at the end of a long line, which had been declared to be impossible by Barlow. He actually set up in the hall of the Albany Academy a line more than a mile in length, through which signals were transmitted without difficulty, and the principles involved were so well understood by Henry that even then, in 1832, he confidently declared that transmission through any

reasonable distance was possible. This system was the germ of all modern telegraphy. At about the same time its development in Europe began, but at first and for many years all European systems were based on the phenomena discovered by Oersted,— the deviation of a needle on the passage of an electric current through a conductor near and parallel to it. While Henry was exhibiting his perfectly-conceived and well-executed scheme for electric transmission to visiting friends, Baron Schilling, a Russian Councillor of State, set up a model of his proposed electric telegraph before the Emperors Alexander and Nicholas, the first of the many "needle" systems which prevailed in Europe for many years, but which were finally driven out by the superior merits of the American system. Schilling's telegraph required thirty-six needles for its operation, besides a complicated device for an audible signal, to attract the attention of the operator.

In connection with his study of magnets, Henry also devised what is now generally known as a "relay," which is an arrangement by means of which an electro-magnet operated by one current is made to close the circuit of another battery, thus enabling a feeble magnet, requiring only a feeble current, to set into operation another, at any point in the circuit. Thus he had evolved all the essentials of a complete telegraph system, lacking only mechanical details which engineering skill and ingenuity might easily have supplied.

Had Henry been less a lover of pure science, or had his commercial instinct been more highly developed, the Albany Academy mile of wire would have grown into the telegraph system of America, instead of furnishing, as it unquestionably did ten years later, the principle upon which that system was founded. It has required a good many years to dispel certain illusions concerning the electric telegraph to which Americans were inclined to cling, but it is now tolerably well known

among intelligent people that the first commercially successful electric telegraph line was *not* erected in this country; that the telegraph can in no sense be called an American invention, although the American system has proved to be so superior that it has long ago practically superseded all others; and that by far the larger share of the credit for the success of this system is due to Joseph Henry for his discovery of the scientific principles upon which that success depended.

In the mean time Henry was engaged in further researches of the very highest importance. He sought to use the powerful magnets which he was now able to construct in the solution of a problem which had thus far baffled the efforts of the ablest electricians in Europe. Having succeeded beyond all others in *producing magnetism by using electricity*, he hoped to be able to successfully attack the inverse problem, the *production of electricity from magnetism*. All physicists believed that this must be possible, but no one had hit upon the method of doing it. Curiously enough, another great experimental philosopher, also a young man, had set for himself the same problem and worked persistently upon it during the month of August, 1831. During the same month Henry began a carefully-planned series of experiments, which, unfortunately, owing to his duties in the Academy, he was obliged to give up, not being able to return to them for nearly a year. Entirely ignorant of Henry's plans, Faraday, on the 30th of August, 1831,—a memorable day in the history of electricity,—made the capital discovery of *induction*, on which practically all modern electrical development is based. Entirely ignorant of what Faraday had done, Henry again took up the subject and had the good fortune to discover the identical phenomenon in another aspect, in which it is known as *self-induction*. In the more recent advances in applied electricity, self-induction has come to be a matter of primary im-

portance, and time has served only to magnify the value of Henry's discovery. Learning of Faraday's experiments, he was led, through their verification, to discover induction by induced currents, concerning which he made a most interesting and valuable investigation. Of his many other important discoveries in electricity there is one that must not be passed without mention. It was, that the discharge of a Leyden jar was oscillatory in character, in which he anticipated Helmholtz and Lord Kelvin in the recognition of a phenomenon which has, within a very few years, come to have a deep import. The present estimate of the value of Henry's work in electricity is reflected in the following remarks, made not long ago by one of England's leading electricians: "At the head of this long line of illustrious investigators stand the names of Faraday and Henry. On the foundation-stones of truth laid down by them all subsequent builders have been content to rest. . . . In them [the scientific writings of Henry] we have not only the lucid explanations of the discoverer, but the suggestions and ideas of a most profound and inventive mind, and which indicate that Henry had early touched levels of discovery only just recently becoming fully worked."

Most of Henry's electrical investigations were carried on at Albany, and afterward at Princeton, whither he was called, in 1832, as professor of natural philosophy in the College of New Jersey. From Princeton he removed to Washington in 1846, to become first Secretary of the Smithsonian Institution, then just established. During his more than thirty years of service in this capacity, administrative duties prevented, in a large measure, a continuation of the scientific investigations for which he was now famous, but they did not diminish his interest in research, nor prevent his doing a good deal of it during the remainder of his life. It must be admitted, however, that he was no longer master of his own

time and energies in this respect. He could not follow his own inclinations, and while the quantity of his scientific work was by no means small, and much of it was of great importance, it was to a large extent such as came to him through the several official positions of great trust and responsibility which he was induced to accept. It will be considered, in this review, under various appropriate heads along with other products of the great Institution to which he gave the best energies of his life, and where, after all, his services have doubtless been more widely useful, and the total integral of their value to mankind greater than if he had devoted himself exclusively to scientific investigation.

Following the general principles already referred to, the Smithsonian Institution has promoted the science of physics in two ways. Original research has been stimulated by the occasional offer and award of prizes for accomplished work, or pecuniary aid has been rendered those engaged in investigation, usually to the extent of assisting in the purchase of necessary apparatus or appliances. Knowledge resulting from investigation thus forwarded by the Institution or *from other sources* has been diffused by publication and extensive distribution among libraries, learned societies, and scientific men. The most tangible results are shown in its publications, as, indeed, they often stand for the activity of the Institution along the lines of both increase and diffusion of knowledge. It is to them, therefore, that especial attention will be given in this review; and, for convenience, they will be classified under the several well-known subdivisions of the subject of physics. The limitation of time and space will not allow of anything like an exhaustive presentation, even in abstract, of all publications bearing the Smithsonian imprint, but the most important will be briefly referred to in approximately chronological order.

ELECTRICITY AND MAGNETISM

THE first paper under this head which the Smithsonian Institution brought out was one on terrestrial magnetism, the first of a long and valuable series of publications on that subject. It appeared in 1852, in the "Smithsonian Contributions to Knowledge."[1] The paper consisted of a series of observations made in the years 1845–'46–'47 to determine the "dip inclination and intensity" of magnetic force in various parts of the United States. Its author was Doctor John Locke, of Cincinnati, Ohio, a well-known pioneer in Western science. Doctor Locke was the inventor of the chronograph, which was first used in astronomical observations at Cincinnati. The method of observing transits by its use rapidly came into favor, was adopted by the United States Coast Survey, and came to be universally known as the "American Method." Doctor Locke's observations on terrestrial magnetism were highly esteemed by Sabine, who made use of them in his contributions to that subject.

The same volume of "Contributions" contained another paper of great interest and theoretical importance on "Electrical Rheometry," by Father Secchi, then recently made professor of astronomy and director of the Observatory in Rome, after having served for a few years as professor of physics in the Georgetown College, District of Columbia. His astrophysical work in later years brought him great fame. The memoir is a mathematical solution, with experimental verification of the problem, "to find the action of a closed current on a magnetic needle, whatever be its position relative to that of the current," and Secchi's treatment of the problem is of much interest, even to electricians of to-day.

[1] Volume III, page 5.

Among earlier papers of great historical interest must be included a lecture printed in the Smithsonian Report for 1854 on "The Fire Alarm Telegraph," by Doctor F. W. Channing, who, with Moses E. Farmer, was the pioneer in this most useful application of electricity. The lecture was one of a course maintained during the years 1853–'54 by authority of Congress, in which a wide variety of topics received popular treatment at the hands of distinguished specialists. That of Doctor Channing was experimentally illustrated, and furnished an excellent account of the beginnings of electrical fire-protection.

The most notable contribution to physics during the next two or three years is to be found in the translation and publication of a series of reports on "Recent Progress in Physics," by Doctor Müller, the famous professor of physics and technology in Freiburg. These reports refer almost entirely to progress in electricity, and the first, printed in the Smithsonian Report for 1855, has to do with what was then almost universally known as "Galvanism." It fills one hundred and fifteen pages, and furnishes an excellent summary of the knowledge of the subject, based on theory and experiment, at the date of its publication. It was followed by another on the subject of "Electricity" (statical) in the Report for 1856, and still others in 1857 and 1858. These summaries are valuable possessions in any physical library, even to-day, and at the time of their publication they must have been a boon to all American students of the subject, for original sources of information were not as common then as now. In 1859 appeared another contribution to terrestrial magnetism, in a series of observations made by Elisha Kent Kane, the Arctic explorer, while on his second expedition in search of Sir John Franklin. These were published in Volume x of the "Contributions." Indeed, for a long time the Smithsonian Insti-

tution especially charged itself with operations in terrestrial magnetism in the United States. In the same year, in Volume XI of the "Contributions," the publication of the very extensive series of Girard College Magnetic Observations, made by Professor Bache, begins, the discussion of the results being largely due to Mr. Schott, of the Coast Survey. These continued through several volumes and years, and there were also included many other studies of terrestrial magnetism made in different parts of the country. For a long time the Institution aided in the development of the subject, both by grants of funds and by publication; the National Academy also contributed largely from the Bache Fund, bequeathed to it for the encouragement of original research, until a comparatively recent time, since which the work has been under government direction, in the United States Coast and Geodetic Survey. The latter bureau shared with the Smithsonian Institution in the expense of the construction and erection of a complete magnetic observatory, giving photographic registration of variations in the magnetic elements. It was first placed on the grounds of the Institution, but in 1860 it was removed to Key West, Florida. The Smithsonian Reports about this time contain papers on magnetic storms, by Sabine; on "Observations on Terrestrial Magnetism in Mexico," by Sonntag, and others of a similar character. Interesting and valuable recent contributions to the same subject will be found in the Reports for 1892 and 1893, the former containing a reprint of Ewing's important Royal Institution lecture on "Magnetic Induction," and the latter Professor Dewar's interesting discourse, at the same place, on the "Magnetic Properties of Liquefied Oxygen."

The publications of the Institution naturally contain much important matter concerning the electric telegraph. Henry's relation to its development has already been referred to, and

in the Smithsonian Report for 1857 an invaluable contribution to its history will be found. It includes his deposition taken in Boston in 1849, as it appears in the record of the Supreme Court of the United States, which is itself a concise history of the invention. In consequence of its appearance, Professor Morse was induced to publish certain statements reflecting upon the integrity and scientific repute of Henry, and this led to an investigation of the whole subject, at Henry's request, by the Board of Regents, resulting in the unanimous adoption of resolutions exonerating him from any charge made by Morse.

Henry's continued interest in meteorology led him to pay much attention to thunder-storms, the effects of lightning, the aurora, studies of atmospheric electricity, earth-currents, etc., all of which found recognition in the earlier publications of the Institution. Among others were papers on "Atmospheric Electricity," by Duprez; on "Earth Currents," by Matteucci; on "The Aurora," by Loomis; and many reports upon the effect of lightning. Henry himself prepared a very valuable circular on "Lightning Rods," giving rules for their erection and proper care. Mention should also be made of another paper of great interest to students of electricity a generation and more ago, on "The Use of the Galvanometer as a Measuring Instrument," by J. C. Poggendorff. One of the earliest methods of "calibrating" a galvanometer is here explained and much information is given relating to what was then in large measure an unexplored field.

Two of the most important papers relating to electricity which the Institution has published are those of Helmholtz and Maxwell in the Smithsonian Report for 1873, presenting the (at that time) latest notions regarding its nature, and Tunzelmann's account of Hertz's researches, which will be found in the Report for 1889. In reprinting monographs

such as these, the Institution is discharging one of its most useful functions by diffusing knowledge not easily accessible among a large number of intelligent people who are generally cut off from original sources.

The Report for 1894 includes several interesting papers relating to electrical subjects. These include one on "Light and Electricity," by Poincaré; another on "The Henry," by Mendenhall; and one on "The Age of Electricity," by Mascart, together with Professor Rucker's address at the Oxford meeting of the British Association for the Advancement of Science, on "Terrestrial Magnetism." There is also an important paper, "On Atmospheric Electricity," by Professor Arthur Schuster, in the Report for 1895.

RADIANT ENERGY — LIGHT AND HEAT

In 1855 there appeared as a part of Volume IX of the "Contributions" a memoir by L. W. Meech, "On the Relative Intensity of the Heat and Light of the Sun upon Different Latitudes of the Earth." A preliminary investigation, suggested by an inspection of monthly temperatures, had been published in 1850 in the *American Journal of Science*. The present investigation was intended to resolve the problem of solar heat and light upon the single hypothesis that the intensity of the sun's rays varies inversely as the square of the distance. It is essentially a mathematical treatment on this assumption, and an attempt is made to show that the conclusions reached are in general accord with physical phenomena. The effect of secular change in celestial constants is examined, and some interesting consequences are deduced. The Smithsonian Reports during the several years following the publication of Mr. Meech's memoir show that much interest

was manifested and that he received assistance in continuing his investigations.

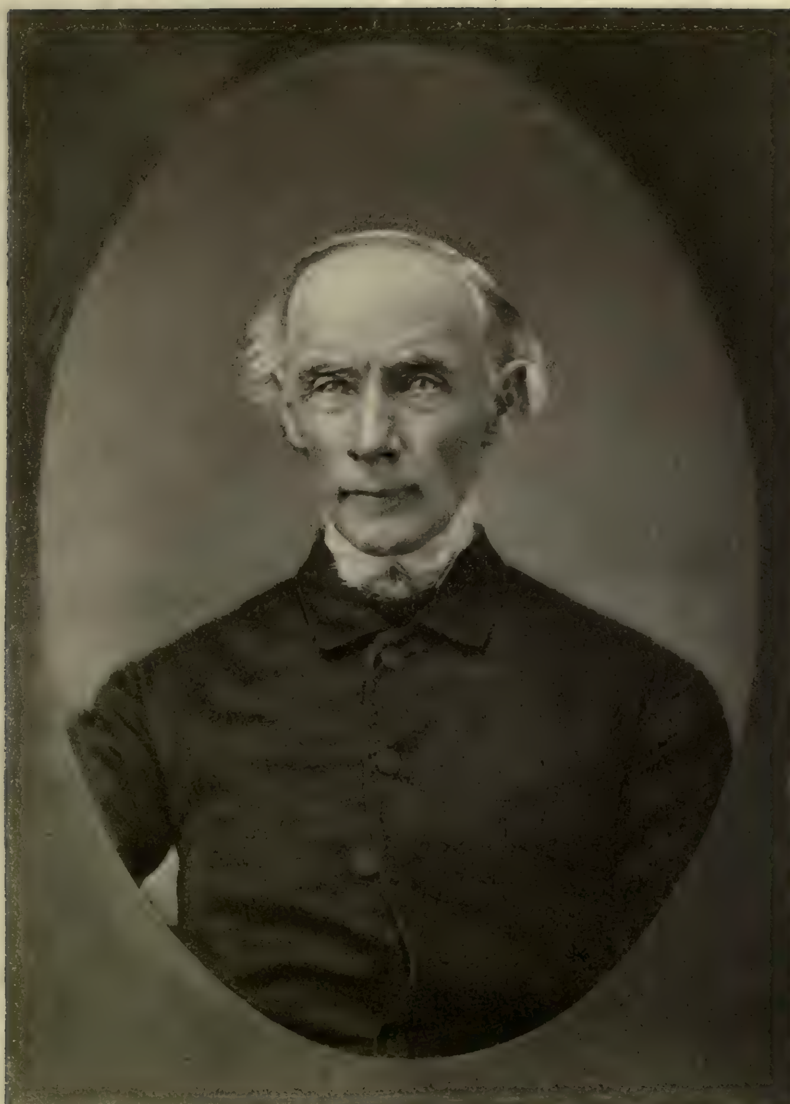
In the same year, 1859, the Smithsonian Report contains a reprint of the highest importance on the subject of "Radiant Heat." It included three reports on the "State of Knowledge of Radiant Heat," made at the meetings of the British Association for the Advancement of Science in 1832, 1840, and 1854, by Professor Baden Powell. New ideas on the nature of heat, based on the work of Joule, Helmholtz, Thomson, and others, were just then beginning to prevail abroad, and they were well known among a few in this country. The reports of Powell, while dealing much more with experimental results than with theory, were very suggestive. Full accounts of Melloni's experiments were given, and some of the early notions of Sir William Thomson about the origin of the sun's heat. Nine years later, in the annual Report for 1868, the now well-established mechanical theory of heat was fully exploited in three very important papers. The first is on the "Recent Progress in Relation to the Theory of Heat," by A. Cazin, and it covers about fifteen pages of the Report. In the second, which is on the "Principles of the Mechanical Theory of Heat," by Doctor Müller, of Freiburg, the new doctrines are fully gone into, and its thirty-five pages constitute not only a strictly scientific, but an exceedingly attractive, exposition of the dynamical theory. The third paper is Tyndall's celebrated Rede Lecture on "Radiation," delivered in 1865, in which, as every one knows, the mechanical theory has full sway.

A large part of the Report for 1862 is devoted to a series of lectures on the "Undulating Theory of Light," by President F. A. P. Barnard. They constitute a tolerably exhaustive treatise on the subject, largely mathematical, and including a discussion of double refraction, polarization, interference

and diffraction, the solar spectrum, etc., with a good account of different theories of light. The Report for 1864 contains Delaunay's classical essay on the "Velocity of Light," the translation having been made by Professor A. M. Mayer, then professor of physics in Pennsylvania College, Gettysburg. The experiments originally projected by Arago to determine the velocity of light, and to settle some controversies regarding the undulating theory, realized so completely by Fizeau and Foucault, are here set forth so perfectly, in a translation so vigorous, that no physicist can fail to acknowledge an indebtedness to the Institution for such an admirable reproduction. In 1866 there appeared an important lecture by Mr. Huggins, on the "Results of Spectrum Analysis Applied to the Heavenly Bodies." This was, in a sense, the beginning of the New Astronomy, in the promotion of which the Institution has been so active in recent years. Mr. Huggins's lecture is a clear presentation of the wonderful discoveries which so rapidly followed the beautiful researches of Kirchhoff and Bunsen. He refers to the assumption, based on a single analogy only, that the fixed stars are essentially similar to the sun, and explains that the new analysis furnishes, for the first time, some decisive proof of this. The principal conclusions reached regarding the structure, material elements, color, brightness, etc., of the stars, the nature of nebulæ and comets, and the possible cause of variable stars, are summarized in a series of propositions which make one marvel at the rapidity with which the new science had grown. The Report for 1877 contains an exhaustive and most timely article on "Color Blindness in its Relations to Accidents by Rail and Sea," translated and somewhat abridged from the French translation of the original paper by F. Holmgren, of the University of Upsala, Sweden. There is also an article on the same subject by Professor Henry.

Little of moment in reference to light or heat appeared in the publications of the Institution for more than a decade after this date, but in 1889 the great advance made during that time found expression in a reprint of Oliver Lodge's excellent lecture on the "Modern Theory of Light," which is a clear and forcible exposition of the electro-magnetic theory of Clerk Maxwell, and of its beautiful verification by the brilliant experiments of Hertz. It is here distinctly recognized that light is only a specially-restricted group out of a great variety of waves emitted by the sun; the importance of devising some means for selective production is emphasized, and it is plainly intimated that the direction along which the next advance is to be made is likely to be "to beat about for some mode of exciting and maintaining an electrical vibration of any required degree of rapidity." A fit accompaniment of Lodge's essay is an address of Professor Joseph Lovering before the American Academy of Arts and Sciences at its meeting of April 10, 1889, on the occasion of the presentation of the Rumford medals to Professor A. A. Michelson. Naturally, the address is a summary of Michelson's principal researches in optics, beginning with his first determination of the velocity of light, by his modified Foucault method, at the Naval Academy about 1878. Professor Lovering's address is not only an account of Michelson's work (up to the date of its delivery), but a very careful examination and presentation of the most important experiments looking to the determination of light-velocity, either in a vacuum or in some transparent medium, together with a statement of the principal results, especially as affecting the solar parallax, and with some reference to theories of light. It is a most admirable and useful contribution.

The first part of Volume XXIX of the "Smithsonian Contributions" is a memoir by Michelson "On the Application of



Interference Methods to Spectroscopic Measurements," published in 1892, an investigation which had been aided by a grant from the Institution. In this work Professor Michelson made use of his well-known interference method, which proved to be very powerful in attacking problems usually given to the grating and prism. He found it "easy to separate lines whose distance apart is only a thousandth of that between D_1 D_2, and even to determine the distribution of light in the separate components," and whenever the width of the lines themselves is less than their distance apart there is no limit to their resolvability.

The Smithsonian Report for 1893 includes a short, but thoughtful, paper on the "Luminiferous Ether," by Sir George G. Stokes, in which the difficulties of the problem are well put and some hints given as to their possible solution.

No account of the relation of the Smithsonian Institution to the increase and diffusion of our knowledge of radiant energy would be approximately complete without reference to the splendid investigations of the present Secretary, Doctor S. P. Langley. Begun originally by him in the Allegheny Observatory, he has not allowed the burden of administrative duties to prevent their being continued in the new Astrophysical Observatory, where they are still in progress. The remarkable results of his use of the bolometer in the study of the infra-red end of the solar spectrum have revolutionized our ideas of the radiations from the sun. A more complete account of this work will be found elsewhere in this volume.

SOUND

ALTHOUGH the number of papers published on acoustics is not large, some of them represent extremely important work.

One of these is a paper read by Henry before the American Association for the Advancement of Science in 1856. Its title was "On Acoustics Applied to Public Buildings." He had been required by act of Congress to build a lecture hall in the building which was erected for the home of the Smithsonian Institution, and he desired to make it acoustically perfect if possible. He had also been consulted, along with Professor Bache, of the Coast Survey, as to the hall of the House of Representatives, which was about to be constructed in the new wing of the Capitol building. With characteristic thoroughness he took hold of the problem, and in its study combined both observation and experiment. He visited the principal halls and churches of Philadelphia, New York, and Boston, and also made an extensive series of experiments upon reflection, resonance, and refraction of sound in rooms and halls of various forms and sizes.

The results of these investigations were utilized in the construction of the Smithsonian hall, which proved to be entirely satisfactory. The paper in which they are embodied is one of the few important and valuable contributions toward the solution of a problem which is still perplexing.

The Report for 1875 contains a very interesting discussion of the laws of refraction of sound, by Doctor William B. Taylor. It is first shown that the velocity of a sound-wave in passing through a gaseous medium may be disturbed by variation in the *density* of the medium, or in its *elasticity* or *temperature*, and also by relative motion of the parts of the medium; that is, by the existence of currents. Whatever produces variations of velocity in different parts of the wave-front will cause *refraction*, as the direction of a sound at any point is perpendicular to the wave-front at that point. Refraction due to variations of density is explained, and the experiments by which Sondhauss demonstrated the existence

of this refraction in 1852 are described. There is a clear presentation of Stokes's theory of sound-refraction due to wind, abstracted for the most part from his paper in the report of the British Association for 1857. He was the first to show that on the side of the source of sound toward the point from which the wind was blowing, the sound-waves would be flattened and the sound "ray" reflected upward, so that sounds would not be heard at distances as great as on the other side, where the effect is to make the wave more convex and to deflect the "ray" downward. This explanation is in harmony with many observed facts, and especially one noticed by Henry in 1865—namely, that a sound moving against the wind, and inaudible to the ear on the deck of a schooner, became audible on ascending to the mast-head. This observation had suggested the idea that sound was more readily conveyed by the upper current of air than by the lower. Some very important practical conclusions came from this principle of wind refraction, one being that a continuous sound, as from a horn or whistle, would be less likely to be lost by refraction due to adverse winds than sounds of practically a single impulse, as from a bell or gun; also that it is more probable that sounds of a high pitch will be more interfered with by refraction than those of medium tones or lower pitch.

Refraction from inequality of the temperature of horizontal layers is also explained at length. This may be of a nature to deflect sound rays up or down, according as the lower or upper stratum of air involved is at the highest temperature. Variations of temperature in the atmosphere along vertical lines are shown to be sufficient to account for many acoustic phenomena with which all observing people are more or less familiar. Among them may be mentioned the extraordinary distance at which sounds may be sometimes heard, especially

at night, and also the remarkable observations made by Arctic explorers, notably Captain Parry, who was able to carry on a conversation with a man a mile and a quarter away. The clearness of sound "over water," which is so generally recognized, is accounted for on the same principles.

This interesting paper is a fitting prelude to the extended and elaborate summary in the Report for 1878 of Henry's researches in sound, conducted in the service of the United States Lighthouse Board during the years 1865 to 1877. Henry's long service as chairman of the Lighthouse Board constitutes by no means the least important of his labors in the interests of the general public. In this service he found opportunity to utilize and apply his knowledge of physical principles and the universally recognized high efficiency of the Lighthouse establishment is due more to his intelligent administration of its affairs than to any other single cause. His researches in sound were among the most valuable of his contributions toward the betterment of the service. As every one knows, the presence of fog along the coast renders the use of sound signals necessary; and for this purpose bells, horns, trumpets, guns, etc., have long been in use. Many curious and often contradictory phenomena have been noted, especially in regard to variations in audibility under different conditions, and the subject is one that has received much attention among maritime nations. Generally under the direction of Professor Henry, the Lighthouse Board conducted an extensive series of experiments during the years mentioned above, the results of which were submitted as reports to the Board and published by it, or, in some instances, read before the Washington Philosophical Society, of which Henry was President. On one of these occasions Professor Tyndall, who was then in the country engaged in lecturing in the principal cities, was present, being interested through his

connection with the Lighthouse service in England and by reason of his own experiments on the absorption of sound. A very decided difference of opinion was developed at a later date between these two distinguished physicists, Professor Henry disagreeing with Tyndall in the matter of the influence of fog, rain, snow, hail, etc., on the audibility of sounds. Tyndall attributed many of the observed abnormal phenomena "to the existence of acoustic clouds, consisting of portions of the atmosphere in a flocculent or mottled condition, due to the unequal distribution of heat and moisture which, absorbing and reflecting the sound, produce an atmosphere of acoustic opacity." Henry, on the contrary, while not denying the possible existence of such a condition, was inclined to attribute such phenomena to the effect of the wind, in accord with the hypothesis of Stokes, referred to in the remarks on the paper by Doctor Taylor. The discussion growing out of this difference of views was of such a nature, unfortunately, as to give rise to some irritation, at least among the friends of the two distinguished physicists, but it is generally believed that subsequent observations have tended rather to confirm the position taken by Henry.

Among the valuable practical results of these researches in sound the development of the use of the siren as an instrument for producing sounds of great intensity must be mentioned.

In his last report to the Lighthouse Board, not long before his death, Henry summarized the results of all experiments conducted by the Board up to that time, a few of the more important conclusions being as follows: The audibility of a sound at a distance (the state of the atmosphere being constant) depends on the character of the sound; to secure audibility at a distance, the pitch of the sound should be "medium"; the loudness, depending on the amplitude of vibra-

tion of the sounding body, should be as great as possible; and the "quantity" of sound, depending on the magnitude of the vibrating surface, should also be great.

The audibility also depends on the state of the atmosphere, the best condition being that of perfect stillness and uniformity of density and temperature. The most efficient cause of the loss of audibility is the direct effect produced by the wind. While, as a general rule, the audibility of a sound is greater on the side toward which the wind "blows," this is due to downward *refraction*, rather than to the simple "carrying effect" of the wind, which would hardly be sensible. Furthermore, there are instances of a greater audibility on the windward side, which is to be explained by reference to a dominant upper wind, opposite in direction to that near the earth's surface.

There is not much utility in concave reflectors or other devices for "directing" the sound along certain lines, for the tendency of the wave is to spread with great rapidity, so that within a distance of three or four miles of the source it fills the whole space of air within the circuit of the horizon and is heard nearly, if not quite, as well behind the trumpet as before it. Neither fog, snow, rain, nor hail materially interferes with the transmission of loud sounds, the siren having been heard at a greater distance during the prevalence of a dense and widely-extended fog than during any other condition of the atmosphere. Projecting portions of the land or buildings may produce sound shadows, so that a sound easily heard at a distance may be inaudible on nearer approach. The existence of an "aërial echo" was established, the explanation of which was not easy to see, although it is probably due to reflection from the surface of the sea.

Investigations of a similar character have been prosecuted in a more or less irregular fashion by the Lighthouse Board

since the death of Henry, but their importance would appear to justify a more vigorous treatment of the subject.

Of a less technical and more strictly scientific character is the reprint in the Report for 1890 of Professor Sylvanus P. Thompson's presentation of Koenig's researches on "The Physical Basis of Musical Harmony and Timbre." This is the address made by Professor Thompson on the occasion of Doctor Rudolph Koenig's exhibition before the London Physical Society of the experimental demonstration and illustration of his theory of harmony. Professor Thompson proved himself to be a charming interpreter and exponent of one of the most accomplished experimentalists and profound students of acoustics of the present generation. Few have done as much as he to advance the science of acoustics, and this paper, which embodies his advance beyond, and departure from, the theory of Von Helmholtz, is a most valuable contribution to science.

METROLOGICAL

A NUMBER of the publications of the Institution are purely metrological in their character. Among these might, indeed, be included the extensive "reduction tables," begun under the direction of Professor A. Guyot, and continued in various revisions and additions, under other editors, up to the present time. They are mostly *meteorological* in character, and doubtless will receive more extensive consideration under that head. They have been of inestimable value to physicists, however, and in their original issue and maintenance the Institution aptly illustrated one of its most important functions.

The early interest felt in systems of measurement is shown in a paper by Professor Guyot, in the third annual Report

of the Smithsonian Institution, now quite inaccessible. It was on the "Advantages of the Metric System in Scientific Investigation," and it doubtless did efficient duty in bringing the system to the attention of Americans at that early day, a half century ago.

The Smithsonian Report for 1863 contains two pages of "Tables of Weights and Measures," and there is nothing to show by whom they were prepared. They are mostly devoted to showing the English equivalents of the various units and denominations of the metric system, although there is also a partial table of English measures. While the Report for 1865 was passing through the press, Congress passed the "metric law" of 1866, the conversion tables in which had been prepared by Professor H. A. Newton, of New Haven. This law and these tables were added to the Report for 1865 as an appendix. As is well known, the fundamental metric value of the yard as then adopted is now the recognized best approximation. It is worthy of note that in the printing of these tables, as well as those of 1863, the spelling of "metre," "litre," etc., and their derivatives is that of the French, and also that in universal use among the English; and it is to be regretted that the Institution has in later years departed from an orthography which has everything to recommend it, in order to adopt one to which there are many serious objections.

Two brief papers, metrological in character, will be found in the Reports for 1889 and 1891. They refer to time measurement, the first being on "Time-Keeping in Greece and Rome," by F. A. Seely; and the second, "Modes of Keeping Time Known Among the Chinese," by Doctor D. J. Magowan. Mr. Seely traces the origin of time-keeping apparatus, of which the sun-dial and water-clock, or clepsydra, are among the earlier forms, and both probably originated in the Orient.

Doctor Magowan shows that at a very early period the Chinese possessed time-keeping devices of considerable complexity, and that the subject of time division and measurement received much attention at their hands many centuries before the Christian Era.

Professor Harkness, in his presidential address before the Philosophical Society of Washington, has given an interesting study of the "Progress of Science as Exemplified in the Art of Weighing and Measuring," and a reprint of it appears in the Report for 1888. It contains much matter of historical value, especially the carefully prepared appendixes showing the principal comparisons of early English and other important standards of length and mass.

The Smithsonian Report for 1893 contains an article on "Fundamental Units of Measure," by T. C. Mendenhall, being a reprint from the *Transactions of the American Society of Civil Engineers*, of a paper read before the International Engineering Congress of the Columbian Exposition. This is a brief sketch of the general principles of metrology, followed by an account of the origin of the English system of weights and measures, and a statement in some detail of the actual condition of the question of "standards" in the United States. The official announcement by the Secretary of the Treasury is there given of the adoption of the national prototype meter No. 27 and kilogram No. 20 as fundamental standards of length and mass, the yard and pound to be defined in the future in terms of these units. The article concludes with the formal announcement of the Superintendent of Standard Weights and Measures, with the approval of the Secretary of the Treasury, of the adoption of the units of electrical measure, with their definitions as formulated and agreed upon by the International Electrical Congress held in Chicago in 1893.

It is a matter of interest to all metrologists to know that through the generosity of Doctor Henry Morton, President of the Stevens Institute of Technology at Hoboken, the Ramsden dividing engine has recently been deposited in the National Museum. The engine was built about 1775, and for its construction Ramsden received a reward from the English Board of Longitude. In an extremely interesting paper printed in the Smithsonian Report for 1890, Mr. J. Elfreth Watkins gives an account of this valuable relic, to which he has added much important information regarding the early history of the division of the circle. There are also some details of the methods of circle graduation by leading artists of a century ago, and the whole forms an important contribution to the literature of the subject.

Under this head should also be mentioned the recent publication (1896) of a set of physical tables prepared by Professor Thomas Gray. These give evidence of great care in preparation, excellent judgment in selection, and a broad knowledge of authorities and literature. Their appearance is very welcome to physicists and all students of exact science.

TERRESTRIAL, DYNAMICAL, AND MOLECULAR PHYSICS

It has already been intimated, and, in fact, every one familiar with its work knows — that the Smithsonian Institution was, especially during the first quarter of a century of its existence, very active in the promotion of terrestrial physics. It originated, cultivated, and maintained a wide-spread interest in the subject of meteorology, organizing a remarkably large and enthusiastic corps of volunteer observers and collecting and discussing data from all reliable sources. In the first

Smithsonian Report were papers by Professors Espy and Loomis, two of the great pioneers in meteorological investigation in this country. Much attention was given to the study and description of American storms, and also to the devising of suitable instruments for meteorological observers. In accordance with its traditional policy, however, the whole meteorological system, which had been developed with so much care, was turned over to the War Department on the organization of the Signal Corps as a weather service, about twenty-five years ago. The work of the Institution in furthering the interests of meteorological science during the first quarter of a century of its existence will be considered in another part of this volume, and further reference to it here is unnecessary. In the Report of 1855 is printed a "Circular Relative to Earthquakes," which Professor Henry had drawn up for distribution after the occurrence of a shock. He submitted nine questions to be answered by any one who had been disturbed by it, none of them requiring any special technical knowledge. He makes a single suggestion as to a "seismoscope" in observing that the direction of the impulse may be ascertained by noting the direction in which molasses, or any viscid liquid, was upthrown against the side of a bowl. Frequent communications descriptive of earthquake phenomena were received and mostly published in the Reports, from time to time. In that for 1859, one of Mallet's important papers, "On the Observation of Earthquake Phenomena," was published. This is a well-known treatment of the subject, admirable in its day, but in large measure obsolete now, especially that part of it which treats of instrumental seismology. An advance along that line is shown in the publication in the Report of 1870 of Palmieri's description of his electro-magnetic seismograph, and the rapid growth of this science is again reflected in the appearance for three years, beginning in 1884, of special Re-

ports on the progress of vulcanology and seismology, prepared by Professor C. G. Rockwood, Jr., of Princeton University. Modern seismology is now represented in the collections of the Smithsonian Institution by a very complete suite of seismological apparatus, devised by Milne, Gray, Ewing, and others, and mostly used in the investigation of seismic phenomena in Japan.

Other phases of terrestrial physics are represented in a paper published in 1860 in the "Contributions," on the "Fluctuations in the Level of North American Lakes," by Whittlesey, and one on "Tidal Observations in the Arctic Seas," published at the same time, in the same place. To these should be added a very valuable paper, which appeared in the Report for 1874, on "Tides and Tidal Action in Harbors," by J. E. Hilgard. Closely related to these are the monographs by General J. G. Barnard, of the United States Engineers, the earliest being on the "Problems of Rotary Motion presented by the Gyroscope, the Precession of the Equinoxes and the Pendulum," which was published in the "Contributions" in 1871. It consists, properly, of three papers, which were separately read before the National Academy of Sciences. The object of the first was to deduce the analytical expression of the precession of the equinoxes directly from the theory of the gyroscope, a suggestion of which the author had made as early as 1857 in an article in the *American Journal of Science.* The second part was a mathematical examination and analysis of the "Motions of Freely Suspended and Gyroscopic Pendulums," and "On the Pendulum and Gyroscope as Exhibiting the Rotation of the Earth," and is an elaborate discussion of the very interesting methods of proving the earth's rotation first suggested by Foucault. The third part is "On the Internal Structure of the Earth as Affecting the Phenomena of Precession and

Nutation." In this General Barnard attacked mathematically one of the most important problems of recent years, and his conclusion was, essentially in his own words, as follows: "Regarding the crust as rigid, I incline to the opinion of M. Delaunay, that the consideration of the phenomena of precession and nutation can furnish no datum for estimating the greater or less thickness of the solid crust of the earth." The second monograph referred to above, published among the "Smithsonian Contributions" six years later, is, in fact, only supplementary to the third part of the first. In the mean time, much had been said upon the subject, especially by Sir William Thomson, and General Barnard very carefully and conscientiously reviews his own work, and in his conclusion says that "the correction of grave errors of conclusion in papers of mine published under the sanction of the Smithsonian Institution, and ostensibly deserving the ascription of 'Contributions to Knowledge,' is a peremptory motive for this memoir." But he further desires to show that in these papers are to be found essential elements of the correct solution of the "full problem of precession and nutation, and what is now necessarily included in it, the tides, for a continuous revolving, liquid spheroid, whether heterogeneous or homogeneous."

The question is again taken up in a reprint from the *Philosophical Magazine*, of an article by Henry Hennessy, who had, in 1878, published a paper on the same subject in the same journal. His attitude in the controversy may be suspected from the statement that "geologists are the ultimate judges of the matter, and not mathematicians." In his final sentence he says that the earth cannot consist of an entirely solid mass composed of equi-elliptic strata, and that it is, therefore, partly composed of a solid shell . . . with an interior mass of viscid liquid, such as is seen flowing from the

volcanic openings of the shell, arranged in strata conforming to the laws of hydrostatics; or, in other words, with strata of equal density decreasing in ellipticity toward the earth's center." The same Report contains Professor R. S. Woodward's vice-presidential address before the Section of Mathematics and Astronomy of the American Association for the Advancement of Science at the Toronto meeting in 1889. This is a historical summary, under the title of "Mathematical Theories of the Earth," of the principal propositions which have been from time to time advanced in reference to the same subject, and is an extremely satisfactory performance. Closely related to these papers are Clarence King's "Age of the Earth," reprinted in the Smithsonian Report for 1893; and Sir Robert Ball's article on "The Wanderings of the North Pole," in the same volume. The former is a valuable contribution to physical geology, the author being, for the most part, in harmony with Kelvin, Von Helmholtz, Newcomb, and other mathematical physicists, who have insisted on a much shorter period of past life for the earth, in anything like its present condition, than is usually claimed by geological writers. The article of Sir Robert Ball, reprinted from the *Fortnightly Review*, is a popular exposition of the recent investigations regarding variation of latitude, in which Doctor S. C. Chandler has been the leader.

At an early period in its history the Smithsonian Institution recognized the importance of the art and science of aëronautics. In the Report for 1860 is an interesting letter from "distinguished citizens of Philadelphia," requesting the Institution to interest itself in a projected passage across the Atlantic "by aëronautic machinery," evidently meaning a balloon as the principal, if not sole, feature. To this Professor Henry replied, giving information regarding some winds which might be depended upon for steadiness, and expressing

a lack of confidence in the feasibility of extensive aërial navigation by any of the methods then proposed, except by floating with the air current in a balloon of sufficient size and of sufficient impermeability to gas to enable it to maintain a high elevation for some time. As might be expected, he counseled more extensive experimentation on land before crossing the ocean was attempted.

The Report for 1863 contains an elaborate account by Arago of several balloon ascensions made in the interest of the advancement of science, and also a brief sketch of some of Mr. Glaisher's ascents. The subject is continued in subsequent Reports, one paper, "On the Various Modes of Flight," in 1867, deserving especial mention, on account of the great amount of information it contains and its clear enunciation of fundamental principles. It is a reprint from the Proceedings of the Royal Institution of a lecture given by Doctor James Bell Pettigrew. A careful study of the flight of birds, bats, and insects is followed by a discussion of the possibility of human flight, and the importance of a "screw" in aërial navigation is enlarged upon.

In the Report for 1869 the matter of flight in the animal kingdom receives attention in the publication of Marey's celebrated lectures on that subject. In the Report for 1889 there is a reprint of a very able discussion of the subject of aërial locomotion by F. H. Wenham, first read before the Aëronautical Society of Great Britain, and published in the annual report of that society for the year 1866.

In the mean time the study of the whole question of aërial navigation, whether by animals or by men, was destined shortly to receive a new impulse through the labors of a small number of scientific investigators who, undismayed by the prevailing belief in the absurdity of the thought of practical flying machines, had attacked the problem in a manner in

keeping with the present knowledge of physics and engineering. Of these none has pursued the subject more assiduously, or made more valuable contributions toward the solution of the problem, than the distinguished Secretary of the Institution, Doctor Langley. The work is still in active progress, but it is proper to say here that the foundation for it was laid, in a large measure, in a series of experiments in aërodynamics, principally carried on in the grounds of the Allegheny Observatory, Allegheny, Pennsylvania. They are to a great extent a study of the aëroplane, and Doctor Langley's report of the work was published among the "Contributions" of 1891. A portion of the work done in Allegheny, supplemented by additional studies made later at the Smithsonian Institution in Washington, gave rise to another very important memoir by the same author, published in the same series in 1893. Its title is "The Internal Work of the Wind." The principal conclusions reached in the investigation are as follows: "That the wind is not even an approximately uniform moving mass of air, but consists of a succession of very brief pulsations of varying amplitude, and that, relatively to the mean movement of the wind, these are of varying direction." From this fundamental proposition, established by experiment, it is inferred that there is a potentiality of "internal work" in the wind which is probably large; that it is no contradiction to known principles of dynamics to declare that an inclined plane or properly-curved surface, heavier than the air and immersed in it, may be supported, or even rise, indefinitely without expenditure of energy other than that necessary to change the aspect of its inclination at each pulsation; also that the possibility of such a surface making advance against the direction of the wind follows not only relatively to the wind, but absolutely in reference to a fixed point. It is hardly necessary to say that these conclusions

are of the utmost importance in the development of practical aëronautics. In the same year the Smithsonian Report contains a paper on "Problems in Flying," by Otto Lilienthal, and another on "Practical Experiments in Soaring," by the same author. The interesting performances of this indefatigable experimenter are well known, and these short papers, taken in connection with the monographs of Langley, constitute a striking illustration of the tremendous advances made in this subject during the past few years.

In studies of molecular physics nothing has appeared in recent years more interesting than the work of Plateau on "Liquid Films and Figures of Equilibrium in Liquid Masses," the first of which appeared in the Smithsonian Report for 1863. Few investigations have exhibited more experimental skill than these, and the exquisite illustrations of the laws that determine the equilibrium of liquid films which Plateau devised and described render his work classical. The wide publications of these important papers, which were continued from year to year in Smithsonian Reports up to that for 1866, constitute almost an era in the development of our knowledge of surface tension, liquid equilibrium, and capillarity. Among other papers on molecular physics which are to be found in the publications of the Institution, one on "Boscovich's Theory," by Lord Kelvin, in the Report for 1887; another on the "Molecular Structure of Matter," by William Anderson, and still another on "Phenomena Connected with Cloud Condensation," by John Aitken, should have special mention. In the volume for 1893 there is a reprint from the *Fortnightly Review* of Sir Robert Ball's article on "Atoms and Sunbeams," which is a popular presentation of the molecular theory of gases, with an application to the maintenance of the sun's heat. The Report for 1892 reproduces two papers on "Solution," one by Professor Ramsay, and the other by Pro-

fessor Orme Masson; and that for 1891 contains an interesting paper by Professor Hallock, on the "Flow of Solids," originally published as a bulletin by the United States Geological Survey. Under the same general class is the memoir by Professor Edward W. Morley on "The Densities of Oxygen and Hydrogen and the Ratio of their Atomic Weights," which appeared as one of the "Smithsonian Contributions" in 1895. In this elaborate research Professor Morley was assisted by grants from the Smithsonian Institution, and he was thus enabled to make by far the most exhaustive study of the subject that has yet appeared, and his results are everywhere acknowledged to possess a degree of accuracy hitherto unapproached.

Reference must not be omitted to a few papers of no great length, but of extreme interest and value, more fully related to dynamical problems, and especially to the theory and measurement of the force of gravitation. Among them is one on the "Nature and Origin of Force," by Doctor William B. Taylor, printed in the Smithsonian Report for 1870, and another by the same author, on "Kinetic Theories of Gravitation," published in 1876. The last is a particularly valuable critical history of the most important theories regarding gravitation from Newton to Clerk Maxwell. In the Report for 1888 there is a somewhat condensed account of Wilsing's determination of the density of the earth by his ingenious "pendulum balance" method. It is worth while remarking, in reference to this, that the Smithsonian Institution has for many years rendered coöperative assistance to scientific men engaged in the determination of the value of the force of gravity. A special room in the basement of the building, particularly adapted to this work, was long ago set aside for use as a pendulum room, and it was for many years regarded as the "base station" for the extensive gravity work of the United States Coast and Geodetic Survey.

MISCELLANEOUS AND TECHNICAL

The publications of the Smithsonian Institution include a large number of papers more closely related to physics than to any other science, but yet of a miscellaneous or technical nature. Brief reference to a few of these will be desirable. One of the earliest is a "Syllabus of a Course of Lectures in Physics," prepared by Joseph Henry and published in the Smithsonian Report for 1856. It was originally intended to continue this syllabus in subsequent reports, but this was not done. As published, it is restricted to a general outline of the course, with an abstract of the general properties of matter and a beginning in mechanics. Although prepared forty years ago, any instructor in physics will do well to examine it carefully. In the same volume there is a paper on the "Mode of Testing Building Material," also by Henry, originally read before the American Association for the Advancement of Science. It is essentially a report of the most important results obtained by a commission appointed by the President of the United States for the purpose of examining the marble used in the extension of the United States Capitol, of which commission Henry was a member. The paper contains a number of interesting conclusions based on the experimental work of the commission, notably those relating to the use of lead plates in crushing cubes of stone; the composition of the marbles used in the wings of the Capitol is given, and there are some thoughtful remarks on the general subject of molecular cohesion, as illustrated in the use of the testing-machine. In the Reports for 1860 and 1861 will be found a course of five lectures on "Roads and Bridges," by Fairman Rogers, then professor of civil engineering in the University of Pennsylvania. They contain much extremely valuable material for a people among

whom even now, a generation later, road-building has hardly passed the temporary stage.

Important technical papers are printed in the Smithsonian Report for 1864, including an extract from the memoir on the "Preservation of Copper and Iron in Salt Water," by Becquerel, the translation of which was furnished by Admiral C. H. Davis, then Chief of the Bureau of Navigation of the Navy Department. This is followed by an equally important paper on the preservation of wood, in which the principal mechanical and chemical methods of treatment are discussed. There is also an interesting paper on "Caoutchouc and Gutta-percha," and also one on the "Products of the Combustion of Gun-cotton and Gun-powder," thus illustrating the marvelous parallel growth of the arts of peace and of war in the United States during these years. In the Report for 1870 there is an almost prophetic letter by Henry, to an unknown correspondent, in reference to the character and importance of a "physical observatory." He refers to his interest in the examination of several European institutions of this class during a recent visit abroad, of the very interesting and important work which they may accomplish, and gives some excellent advice as to their organization and management. There is one sentence which cannot be too frequently quoted, in which he says, "It is, therefore, in the highest degree injudicious in the founding of an establishment to exhaust the source of its power by architectural display not absolutely required, and which may forever involve a continual expense from the remaining funds to keep them in repair." He speaks of finding in England "observations which have challenged the admiration of the world," carried on in a temporary structure made of rough boards, unplastered, and hardly more than fifteen feet square. This condition of things the Institution has itself practically repeated after a score of years.

In 1873 there was issued among the "Miscellaneous Contributions" the beginning of a very important series of statistical publications, under the general title of "The Constants of Nature," by Professor F. W. Clarke. Part 1 of the series consists of a table of specific gravities, boiling and melting points for solids and liquids, and chemical formulæ. It has been supplemented and revised from time to time, the latest addition bearing date of 1888. Other volumes contained tables of specific heats, coefficients of expansion, etc., and that containing atomic weights was compiled by Mr. G. F. Becker. The whole series, to which additions are being continually made, has hardly a rival in any language, and its issue well illustrates the usefulness of the publication feature of the Smithsonian Institution. The Smithsonian Reports for 1873 and 1874 contain a technical paper of considerable length and great value "On Warming and Ventilating Occupied Buildings," by the well-known French engineer and technologist, Morin. Its reproduction was most timely, for little consideration was given this important matter by architects and builders a quarter of a century ago. The Report for 1880 contains a reprint from the report of the United States Lighthouse Board for 1875 of Henry's "Investigations Relative to Illuminating Material," made in the interest of the Lighthouse establishment. This is a detailed account of the earlier stages of the study of illuminants carried on by the Board during the past thirty years, which has resulted in the exclusive use of petroleum oils in the Lighthouse service. Professor Henry's report brings the work down to the *beginning* of this use.

With the Report for 1880 there was begun a series of annual "Reports of Progress" in the various branches of science, prepared by well-known specialists. This series was discontinued in 1888, for reasons given in the Smithsonian

Report for that year. The editing of the "Progress in Physics" was during these years assigned to Professor George F. Barker, of the University of Pennsylvania, and no one else so well fitted for the work could have been found. The series of "Reports of Progress," which appeared from 1880 to 1887, as far as it relates to the science of physics leaves nothing to be desired; the references to original sources are very complete, and both the busy specialist and the intelligent student of general physics willingly acknowledge their indebtedness to Professor Barker and the Institution. It is not yet certain that any other publication exactly fills the place of this.

A few other publications of a miscellaneous or technical character remain to be noticed, one of the most important being Professor Huxley's famous "Jubilee Year Address" on the "Advance in Science in the Last Half Century," which will always stand as a classical contribution to the scientific history of a remarkable period. Emblematic of the growth of engineering skill during the same period are the carefully-prepared papers on the Eiffel Tower in the same volume. A technical paper of much interest "On the Absolute Measurement of Hardness," by F. Auerbach, is published in the Report for 1891, the English translation of which was furnished by Professor Carl Barus; while the volumes for 1890 and 1893 contain examples of splendid experimental skill, in two papers by Professor Boys, the first being the celebrated Royal Institution lecture on "Quartz Fibers," and the second that on "Electric Spark Photographs of Flying Bullets," delivered in 1892 at the Edinburgh meeting of the British Association for the Advancement of Science. The "Quartz Fibers" lecture was almost epoch-making in character, for it introduced to general use a simple and elegant device for the suspension of light bodies, which has enormously increased the accuracy of a large and important class of physical measure-

ments, a remarkable example of which is to be seen in the work of Professor Boys himself in his classical determination of the constant of gravitation.

By no means the least important publications of the Smithsonian Institution have been the series of memoirs, eulogies, biographies, and autobiographies of distinguished scientific men which have been printed in the Smithsonian Reports from the earlier to the later issues. Great interest attaches to the personality and private life and character of men of distinction, and this is no less true in science than elsewhere. Besides, these memoirs and eulogies often furnish the most complete and concise account of the scientific work of their subjects, and furnish information of this kind not elsewhere available. The Smithsonian Reports have put into the hands of physicists biographical memoirs of such men as Priestley, Delambre, Faraday, Eaton Hodgkinson, Thomas Young, Herschel, Laplace, De la Rive, Volta, and Kirchhoff, among others, and four of these came from Arago, whose own autobiography, entitled "The History of My Youth," published in the Report for 1870, is one of the most charming sketches to be found in any language. The memoir of Kirchhoff, by Von Helmholtz, is full of interest to every physicist, and the "Historical Sketch of Henry's Relation to the Telegraph," by Doctor W. B. Taylor, published in the Report for 1879, is a document of great scientific value.

Another interesting and valuable feature of the Smithsonian Reports is the publication from time to time of reports on the transactions of various European societies, especially the Society of Physics and Natural History of Geneva, abstracts of whose transactions were published annually for nearly a quarter of a century.

The publication of prize problems and of medals and prizes offered by various scientific societies, including the In-

stitute of Bologna, the Holland Society of Science, the Imperial Academies of Science in Bordeaux and Vienna, the London Institution of Civil Engineers, the Royal Academy of Science in Brussels, the Royal Prussian Academy of Science, and others, was a matter of interest to men of science in America, and was greatly helpful in directing their efforts.

In the above review of the work of the Institution along the line of physics, it has been impossible to look much beyond what is reflected in its numerous publications. Throughout its fifty years of existence there has been something besides this, however,— less tangible, it is true, but often more effective,— in the ready disposition of its authorities to render assistance to every man engaged in original investigation which was likely to prove of value, and for which support was not easily obtained from other sources. Many physicists, in America and elsewhere, can testify to the valuable coöperation of the Institution. To the general public it has been easy of access, and its resources in the way of obtaining information have always been at their command. The Smithsonian Reports have been especially valuable as a means of diffusing a knowledge of the more important advances in physical science, for there is hardly a discovery of moment, or a notable expression of opinion on the part of a man of distinction, that has not found a place in this most valuable annual. All scholars note with pleasure its increase in size from year to year, and physicists welcome the increasing recognition of their science. Under the wise direction of one of the first physicists of the present time, it is natural to indulge in the hope and expectation that in the years to come the Smithsonian Institution will be, even more than in the past, the center of intellectual activity of the Western Continent, and the friendly patron of original research everywhere.

MATHEMATICS

By Robert Simpson Woodward,

Professor of Mechanics, Columbia University

L'idée du progrès, du développement, me paraît être l'idée fondamentale contenue sous le mot de civilisation.—Guizot.

AMONGST the causes which have made for civilization during the past half-century, the progress of science, it would seem, must be given a very prominent, if not the first place. Governmental, commercial, social, ethical, and religious institutions and influences have each played an important rôle in the general advance of humanity; but the pervading thought, the points of view, and the intellectual activities have been predominantly scientific. To the world at large the most striking results of this progress of science are found in material benefits. The ease of intercommunication by telegraph and telephone; the facility of transportation by railway and steamship; the prevention of disease by rational sanitation, and the mitigation of pain by rational surgery, along with a multitude of other benefits, appeal directly and forcibly to the popular sense. To the student of civilization, on the other hand, the most important results of that progress are found in the development of a dis-

tinctively scientific method of investigation, and in the discovery of two far-reaching laws of nature, namely, the law of conservation of energy and the law of evolution of organic forms.

The scientific method is not new. It has been followed more or less closely throughout the history of modern science. From Galileo to Newton, from Newton to Laplace, from Laplace to Darwin, the same method of patient observation, of measuring, of weighing, of correlating, is discernible. But it has now reached such a degree of definiteness, and its efficiency in the search for truth is now so generally recognized, that it has come to be known by common consent as the scientific method. Subjects as diverse as philology and cosmogony, substances as different as zinc and protoplasm, media as distinct as the air and the ether, systems as widely separated as those of Sirius and Jupiter, have each been subjected to the observation, the experiment, and the reasoning which are characteristic of this method. By its aid, indeed, almost every field of inquiry has been cultivated, and few fields have failed to yield fresh accessions to knowledge.

In the domain of the mathematico-physical sciences no generalization of the period in question is comparable in importance with that of the doctrine of energy. In this doctrine the earlier conception of the impossibility of perpetual motion is replaced by the clearer and broader conception of the impossibility of creating or destroying energy. All mechanical systems, and all of the varied mechanical phenomena presented by the universe, are thus held to exhibit the common property of conservation of energy. It is to the recognition of this law that are due in a large degree the recent remarkable developments in the useful applications of thermodynamics, electricity, and magnetism; while the exigencies of those developments have stimulated in a noteworthy man-

ner numerous researches in pure mathematics. As a corollary, almost, has resulted also a more or less complete correlation of the sciences of heat, light, electricity, and magnetism; and a still further correlation, if not a complete unification, is confidently expected. In the rational investigation of physical phenomena the question of the energy involved is everywhere uppermost; and no such investigation meets the requirements of the present day unless the source, the transformations, and the resultant form of the energy are accounted for.

Along with the rapid growth and multiplication of the sciences which have been such prominent characteristics of the civilization of the past half-century, there is noticeable also a rapid growth in the interrelations of those sciences. Chemistry, for example, has come to be closely allied to physics; physics is largely applied mechanics; geology shades off by easy gradations into physical geodesy; physical geodesy is only a branch of dynamical astronomy; while mathematics is an indispensable instrument for all of them, and biology must evidently in the near future draw heavily on most of them for the solution of its problems. It is in this growth of interrelations that one may discern the beginnings of correlations and generalizations which will simplify and unify the appalling aggregate of knowledge now presented by the sciences. And it is thus that the evils of specialization, which have been somewhat deplored of late, evils necessary to the fact-gathering stage of the sciences, will find their proper correction.

If such have been the characteristic features of the progress of science in general during the past fifty years, what rôle is to be assigned to the mathematical work which has been promoted directly or indirectly by the Smithsonian Institution in the fields of American science? To the casual reader of the bulky catalogue of the "Contributions to Knowledge," "Mis-

cellaneous Collections," and "Annual Reports," issued in 1886, it might appear that the Institution has done little toward the increase and diffusion of mathematical knowledge. But no such conclusion can be justly reached in the light of anything like a comprehensive view of the work of the Smithsonian Institution in the advancement of science. It is, indeed, essential, first, to understand this work as a whole before any of its parts can be duly appreciated. Relatively, it is clear that mathematics, the oldest and most perfect of the sciences, has been much less in need of encouragement during the period in question than the physical and natural sciences. Moreover, the necessities of American life have called, until very recently, for the applications rather than for the abstract theories of mathematics. It is a natural and logical outcome, therefore, of the conditions of science and of American life that the bulk of the work of the Institution should be found in the physical and natural sciences. But these, in the aggregate, require for their interpretation the whole range of mathematics; and since it is through the concrete that the abstract is approached, the diffusion of mathematical knowledge has doubtless been greater by this indirect process than it could have been by any direct means. Thus the encouragement and aid given by the Smithsonian Institution to astronomy, geodesy, meteorology, and physics, especially, must be rated as of great importance; for mathematical studies in this country have been cultivated hitherto chiefly as a means to the attainment of the objects of those other sciences.

The history of the Smithsonian Institution is practically coextensive with the history of the Naval Observatory, organized in 1842, and with that of the Coast and Geodetic Survey as reorganized in 1843. In these governmental bureaus which make extensive use of pure and applied

mathematics the Institution has always shown a lively interest, and much of the success of their earlier work seems to be directly traceable to the wise counsel and warm support of Joseph Henry. The more recent governmental organizations, the Weather Bureau and the Geological Survey, whose work is also largely dependent on mathematical science, have drawn their inspiration, as well as a great part of their working data, directly from the Smithsonian Institution.

The interest taken by Joseph Henry in the progress of the more abstruse mathematical theories of astronomy and geodesy forms a noteworthy feature of his annual reports. These reports show that the Institution was in touch with the ablest mathematicians of the country, and that no branch of their science was so abstract as to be beyond the recognition and aid of the Secretary. It seems strange in the present day of open avenues to the publication of meritorious works that at a time less than fifty years ago there could have been difficulty in finding a publisher for so great a treatise as Professor Benjamin Peirce's "Analytical Mechanics." Still more strange does it appear that the coöperation of the Smithsonian Institution with the Navy Department should have been essential to secure the publication of so important a work as Davis's translation of Gauss's "Theoria Motus Corporum Cœlestium." But publishers in those days found little demand for, and less profit in, contributions to knowledge. Science as such had not yet been recognized by the colleges, and there were only a few men, mostly in the Eastern States, who found in their surroundings any encouragement of their devotion to abstract studies. Even the government bureaus, like the Naval Observatory, the Nautical Almanac Office, and the Coast and Geodetic Survey, had not yet reached an independent footing in regard to the publication of researches indispensable to the progress of their work. It is only in the light

of these circumstances that one can appreciate the value of the services rendered by the Smithsonian Institution in the encouragement of mathematical research in this country during the fifteen years preceding the outbreak of the Civil War. At the time of the publication of Peirce's "Analytical Mechanics," in 1855, as appears from the list of subscribers, there were in the United States only nine institutions or libraries whose authorities or patrons evinced any desire for such a work. Of these institutions the Smithsonian was the leading subscriber, undertaking the distribution of twenty-five copies of the treatise, while its merits were the subject of special remark by the Secretary in his annual report of the time. A little later, in 1857, through the good offices of Joseph Henry, was brought out Davis's translation of the master-work of Gauss already referred to. It was in this period, likewise, that the Smithsonian Institution extended its aid to the mathematical monthly founded by Professor J. D. Runkle in 1858, which promised to give an important stimulus to mathematical work in this country, but which failed to secure adequate support with the advent of the absorbing questions of the Civil War. During these *ante-bellum* days, also, were begun, largely through the influence of Joseph Henry and the aid of the Smithsonian Institution, those invaluable researches in terrestrial magnetism which have since been so widely extended by the Coast and Geodetic Survey through the indefatigable labors of Mr. Charles A. Schott. In the laborious and refined calculations required by such researches Henry evinced, as shown by his annual reports, the warmest interest, even going so far as to call conspicuous attention to the application of Peirce's criterion for the rejection of doubtful observations in the discussion of magnetic and meteorological data. In later years, also, he did much to stimulate mathematical research in dynamical

astronomy, physical geodesy, and mechanical meteorology, some of the most important papers of the century on these subjects being directly due to his suggestions and encouragement. Throughout his career as Secretary he was in close contact with the most profound mathematical thought of the day, and although not a professed mathematician, few men of his time could have been more fertile in suggesting subjects for mathematical research. Science knows no nationality, but the pride of Americans may be excused for entertaining a regret that Henry did not have his mathematician as Faraday had his Maxwell.

Of the various mathematical, geographical, magnetic, meteorological, and physical tables giving numerical data and rules for their application, published by the Smithsonian Institution, little need be written here. Suffice it to remark that these tables have been widely used, and are of great utility; while their educational value has doubtless been of equal importance with their practical usefulness. Intimately related to these tables, and in many cases incorporated with them, is the information which the Institution has disseminated with regard to the simplicity and advantages of the metric system, whose adoption by our country seems now near realization. Since the legalization of the use of the metric system in the United States by act of Congress in 1866, the Institution has published many tables facilitating the interconversion of English and metric weights and measures. The most elaborate of these were prepared by Professor H. A. Newton in 1866. The importance of this information, freely disseminated by the Institution, can hardly be overestimated by one who looks beyond his own day and generation.

As an indirect means for promoting the cultivation of mathematics, the numerous memoirs on mathematico-physical

subjects published by the Smithsonian Institution must be rated as of great importance. Among these may be cited the astronomical papers of Walker, Gould, Runkle, Newcomb, and Stockwell; the papers on heat, light, electricity, and magnetism, by Meech, Bache, Barnard, Müller, De La Rive, Helmholtz, Maxwell, and others; the papers on meteorology of Henry, Schott, Coffin, and Abbe; the remarkable researches of Plateau; and the more recent elaborate summaries of current progress in astronomy, geology, meteorology, and physics. Falling, as these papers have, under the eyes of a great many readers, they cannot have failed to produce a wide-spread interest in the one science which is a common necessity to all sciences that have to deal with quantitative relations. To this general diffusion of mathematico-physical knowledge by the Smithsonian Institution must be ascribed, in a large measure, the noteworthy impulse which mathematical study and research have acquired in the United States during the past two decades.

Another indirect means, no less potent than that just mentioned, in stimulating mathematical inquiry is found in the numerous memoirs on, and biographies of, distinguished devotees to the mathematico-physical sciences published in the annual Reports of the Smithsonian Institution. Nothing is more interesting and inspiring, for example, than Arago's admirable biographical notices of Laplace, Young, Herschel, Ampère, and others, which have been translated by the Institution and given wide publicity through those annual Reports. In this connection, also, mention should be made of the semi-popular addresses on various subjects in the physical sciences, which have likewise reached the reading public through the annual Reports. The seeds of knowledge and inspiration sown broadcast in this manner have taken root in many minds; and it is doubtless due in no small degree to the

general enlightenment thus disseminated that something like adequate provision has been recently attained in our colleges and universities for the pursuit of the higher branches of mathematical science.

A summary comparison of the status of mathematical science in our country at the time of the foundation of the Smithsonian Institution with the present status shows that great progress has been made during the half-century which has since elapsed. At the beginning of this period a few only of our educational institutions afforded opportunities for the pursuit of studies in mathematics beyond the elements of algebra and geometry. Now almost every State in the Union has a college or technological school whose curriculum embraces the calculus, with its applications to mechanics, astronomy, geodesy, etc.; and not a few of our institutions of learning are provided with the libraries and the teaching staff essential to the prosecution of research in the most advanced fields of pure and applied mathematics. At the beginning of this period there was no journal in the country devoted to purely mathematical work. Now there are three such journals, while many others offer ready publication to the physical and technological applications of mathematics. During the past two decades, particularly, there has been a noteworthy development throughout the country of interest in all branches of pure mathematics. Quite recently our mathematicians have organized an association, under the name of the American Mathematical Society, for the special purpose of advancing their favorite science; and the reproach of Europeans that we have hitherto shown little capacity for cultivating the more abstract domains of mathematics seems destined to be removed in the near future by the formation of a distinctively American school of mathematicians. Not less striking and gratifying than these advances in a theo-

retical and educational way are the advances made in the way of applications in the mathematico-physical sciences. Observational and dynamical astronomy, geophysics, meteorology, thermodynamics, and engineering in all its branches have nowhere been cultivated more diligently and successfully during the past fifty years than in the United States. Many individuals and many institutions, of course, have contributed to bring about this progress; but all have been animated by the same desire that has been so effectively carried out by the founder and the administrators of the Smithsonian Institution, a desire to increase knowledge and to diffuse knowledge among men.

ASTRONOMY

By Edward Singleton Holden

Director of the Lick Observatory

IT is the object of the present chapter to set forth, with such fullness as is permitted by the necessary limitations of space, the services of the Smithsonian Institution to astronomy during the half-century of its existence, from 1846 to 1896. In this department of science, as in others, the Institution has steadily kept in view the two high ideals formulated by its founder — namely, the increase of natural knowledge and its wide diffusion among men.

In the prosecution of these ideals it has engaged in the most diverse investigations, either directly or indirectly. Directly — by the individual researches of its Secretaries and other officers: indirectly — in varied ways; by personal influence upon scientific societies and individuals and with Congress; by service upon scientific boards and councils; by advice in the formation of scientific programs; by subsidies freely granted in aid of research; by the loan of its halls or apparatus for special investigations; by opening the pages of its publications to the printing of scientific memoirs and of popular summaries and bibliographies; and by distributing

these and other publications, without cost, to thousands of its correspondents all over the civilized globe.

It is by these and like services to the world at large that the Institution is known and valued among the wide community of scientific men.

But this enumeration does not in itself exhibit the immense influence which it has exerted in its own country. Up to the beginning of the war of the Revolution American science was in leading-strings as the child of British learning. It was not until the first third of the present century had elapsed that any considerable part of the energies of our young country could be turned from pressing material needs and devoted to scientific ends. It was of the first importance that the beginnings of independent investigation among Americans should be directed toward right ends, and by high and unselfish aims. In the formation of a scientific standard among us, a few names will ever be remembered, and among them that of Professor Henry, the first Secretary of the Smithsonian Institution, stands preëminent. The ardent spirit of his early manhood excited his contemporaries to a generous emulation, and it ripened with time to a broad, grave, and kind wisdom, which profoundly influenced a younger generation of scholars, his successors and his scientific children.

It is not unlikely that the greatest service of the Smithsonian Institution to the country has been the constant exhibition, in its general policy and in its daily relations for half a century, of a high and generous ideal. Its influence in this direction cannot be over-estimated; and the source of this influence was in the character of its organizer. Any sketch of its services would be most inadequate which failed to emphasize this fundamental point.

A complete list of all the publications of the Smithsonian

Institution during the fifty years of its existence is given elsewhere. By consulting this list the chronological order of its contributions to astronomy can be seen. I have chosen to arrange the present chapter not chronologically, but by subjects, so as to bring out more prominently the very varied activities of the Institution and its unfailing and impartial sympathy with any research likely to increase the sum of knowledge.

SOLAR ECLIPSES

The Institution has taken an active part in researches connected with solar eclipses by preparing and distributing information concerning them, and by subsidizing expeditions to observe their phenomena.

In 1851, Doctor Busch, of Königsberg, had made a daguerreotype of an eclipse. The annular eclipse of May 26, 1854, was observed in the United States, according to instructions sent out by the Institution, and was photographed by Professor W. H. C. Bartlett in West Point, and by Professor S. Alexander in Princeton. The expense of these experiments was borne by the Smithsonian Institution.

The eclipse of September 7, 1858, was observed by Lieutenant J. M. Gilliss at Olmos, in Peru, by the aid of a subsidy from the Institution, and his report is printed in Volume XI of the "Contributions to Knowledge"

The eclipse of July 18, 1860, also was observed by expeditions sent from the Smithsonian Institution under Professor Alexander (to Labrador) and Lieutenant Gilliss (to Washington Territory).

Among the collections of the Institution is a map constructed by Professor J. H. Coffin, "on which are delineated the paths of all the great solar eclipses of the nineteenth cen-

tury which traverse the United States. These are nine in number. Seven of them have passed; the first of the remaining two will occur in October, 1865, and the other in August, 1869." The foregoing quotation, from the Report for 1854, is interesting as showing, incidentally, how the distribution of the population in the United States has changed since 1854, for besides those named there were two other great eclipses visible within our territory — namely, that of July, 1878, from Wyoming to Texas; and that of January, 1889, in northern California and Nevada; but in making his map of 1854 Professor Coffin did not think it worth his while to chart these tracks which passed through unknown wildernesses. They were both well observed, however, by parties who traveled by railway from the Atlantic seaboard, bringing complete equipments in photography and spectroscopy.

The Reports of 1878 and of 1879 refer to a work by Professor D. P. Todd, undertaken under the auspices of the Institution, relating to the interpretation of the observations of ancient eclipses of the sun, with special reference to the determination of the moon's secular acceleration. This work has not yet been published.

A series of photographic prints of the corona as seen at the total solar eclipse of January, 1889, was issued by the Institution under the editorship of Professor D. P. Todd, as a separate quarto, but was not included in the regular series of "Contributions to Knowledge." It consisted of nine pages of text, with two photographic plates, showing nine different views of the solar corona during the total eclipse.

This comprises all of the active work pertaining to solar eclipses that has been accomplished by the Smithsonian Institution, although the United States National Museum has profited greatly by collections that have been gathered by the different parties sent out.

THE SOLAR CORONA DISCUSSED BY SPHERICAL HARMONICS, BY PROFESSOR FRANK H. BIGELOW

THE structure of the solar corona, as exhibited on photographs, consists of polar rays, four "wings" symmetrically disposed on two axes, and extensive equatorial wings. These appearances seen in the meridian section must be translated into corresponding zones and sectors on the figure of revolution of the sun. The paper of Professor Bigelow proposes to make this interpretation by the theory of spherical harmonics, on the supposition that we see a phenomenon similar to that of free electricity, the rays being lines of force and the coronal matter being discharged from the body of the sun, or arranged and controlled by these forces. The first business of the paper is to put these pre-suppositions into mathematical form, and to construct the theoretical lines of equipotential and of force.

This theory once formulated, the next step is to test it by the corona, and for this purpose the corona of January, 1889, is chosen, as exhibited on the photographs made by the parties of the Lick Observatory and of the Harvard College Observatory. The test has been applied by the author to the two photographs, and his conclusion is that the phenomena displayed on the photographs are explained by the theory. The paper is admittedly a provisional one, and it forms part of a much wider research now in progress on the problem of the transference of energy from the sun to the earth.

This paper comprises twenty-two pages and is illustrated with four diagrams, and one phototype plate. It was published in quarto form in the same style as that of the "Smithsonian Contributions to Knowledge," but was not included in the volumes of that series. It was given to the public in 1889.

LIST OF OCCULTATIONS VISIBLE IN THE UNITED STATES, AND ELSEWHERE

AT the date of the foundation of the Smithsonian Institution (1846) the vast territory west of the Mississippi River was unmapped, and, in a large measure, unknown. One of the first practical duties of astronomers was to take scientific possession of it — to determine the latitude and longitude of points within it which would serve as origins for detailed surveys.[1]

The great precision of longitudes determined by observations of occultations was early recognized by American astronomers,[2] and from the year 1848 onwards, lists of such phenomena were printed and distributed by the Smithsonian Institution. The calculations and tables were made by Mr. John Downes, and his results were of great service to the officers of the United States Coast Survey, to the topographical engineers of the Army, and to other explorers and surveyors. They were especially useful in the newly-acquired territory on the Pacific Coast.

Faithful to its general and wise policy, the Institution carried on the preparation and publication of these tables until the establishment[3] of the "American Ephemeris" enabled a transfer of this responsibility to be made to other competent hands.

1 "When we consider the character and condition of the vast Continent of North America, which it belongs to us chiefly to reduce to a habitable and civilized state, we shall perceive that the practical scientific explorer has no higher duty than to settle the geography, the magnetism, the natural history, and the climate of these regions."—"Smithsonian Report," 1852, page 237.

2 Occultations were regularly observed at Harvard College Observatory during the years 1846 to 1850. See "Memoirs of American Academy of Arts and Sciences, Second series," Volume III, 1848.

3 The preparation of the "American Ephemeris" was begun in 1849, and the theoretical portion of the work was placed under the direction of Benjamin Peirce, of Harvard University.

LUNAR PHOTOGRAPHY

THE Report for 1893 contains the following paragraph on this subject, written by Doctor Langley, explaining the plans of the Institution:

"I have been interested for a considerable time in the possibility of preparing a chart of the moon by photography, which would enable geologists and selenographers to study its surface in their cabinets with all the details before them which astronomers have at command in the use of the most powerful telescopes. Such a plan would have seemed chimerical a few years ago, and it is still surrounded with difficulties; but it is probable that within a few years it may be successfully carried out.

"No definite scale has been adopted, but it is desirable that the disk thus presented should approximate in size one two-millionth of the lunar diameter; but while photographs have been made on this scale, I do not think any of them show detail which may not be given on a smaller one. I have been favored with the coöperation and interest in this work of the director of the Harvard College Observatory, of the Lick Observatory, and others, who, in response to a letter addressed to them on February 10, 1893, have obliged me with many valuable suggestions. This important work is still under advisement."

In aid of experiments in lunar photography at the Lick Observatory, several small and timely grants of money have been made.

The present state of the research at Mount Hamilton is that its focal negatives (about five and one quarter inches in diameter) are being enlarged by photography to a scale of ten feet to the diameter by Professor L. Weineck, Director of the Observatory in Prague, and it is expected that a complete

atlas of the whole moon will soon be published on this scale from Lick Observatory negatives chiefly (a few sheets from the excellent Paris negatives) by the aid of a grant from the Vienna Academy of Sciences.

An enlarging lens provided by the Smithsonian Institution allows direct enlargements in the telescope (5 diameters) to be made, and the resulting grain of the plate is proportionally finer. It is the hope of the Lick Observatory to prepare the plates for two complete maps of the moon from these direct enlargements,

First: To a scale of three Paris feet to the diameter (the scale of Mädler's map);

Second: To a scale of six Paris feet to the diameter (the scale of Schmidt's map).

The first of these will serve for most observatory purposes, and for a general portrayal of the lunar features. Several sheets of this map have already been published.

The second will be especially fitted for a more detailed exhibition of the geologic and topographic features in the manner referred to by Doctor Langley. Nothing but the great expense of the plates prevents the immediate prosecution of these plans.

THE ORBIT OF NEPTUNE

NEPTUNE was discovered in 1846 by Professor Galle in Berlin from predictions by Leverrier, and the announcement of this brilliant achievement was received with enthusiasm in Europe and in America.

It was essential to calculate its orbit as soon and as completely as possible from the short arc of its path traversed since the first observation of Galle. If, by chance, the planet

had been previously observed as a fixed star, it would be of great importance to recover such an observation, and thus to make a longer arc of the planet's orbit available.

Professor Sears C. Walker, at that time one of the astronomers of the United States Naval Observatory, undertook the investigation, utilizing the first four months during which the planet had been under observation.

He first computed a preliminary orbit, and traced the motion of the planet backwards to determine in what portion of the sky and at what time it might possibly have fallen among the fixed stars of some catalogue and have been observed as one of them.

His methodical manner of procedure was sure to detect such an observation if it had been made, so that it was by no accident that he discovered an ancient determination of the position of the planet among the zone observations of Lalande in 1795.

In this way a position of the planet was obtained fifty years earlier than the date of its discovery, and a long arc of its orbit was determined by observation instead of a very short one. With the data thus available Walker calculated new elements of the planet and prepared ephemerides of its positions each year from 1846 onwards. Much of this computation was done at the expense of the Smithsonian Institution, and the results were duly printed in the "Contributions to Knowledge" and they constitute a work of sterling value.

The orbit of Neptune was also investigated by Professor Peirce, of Harvard College, and the principal perturbations calculated, so that the pure elliptic orbit of Walker could be corrected for the action of the disturbing planets, and the ephemeris correspondingly improved. The discovery of Lalande's early observation, and the prompt utilization of it

by Walker, was a genuine service to science by American astronomy.

A perusal of this and other works of Walker — and of those of Coffin, Gould, Gilliss, Hubbard, Peirce, and others, his colleagues and contemporaries — will go far to exhibit to students of the present generation how thoroughly American astronomy of fifty years ago was grounded in the classic methods of Gauss, Bessel, and Struve.

A very complete history of the discovery of Neptune, written by Doctor B. A. Gould, was printed and distributed by the Institution in 1850 as an octavo pamphlet.

The "Contributions to Knowledge"[1] in 1866 contains an investigation of the orbit of Neptune and tables of its motion, being the first publication of the long series of such researches which are owed to Professor Newcomb.

The theory of Neptune had previously been investigated by Peirce and Walker in America, and by Kowalski and Wackerbarth in Europe. But in 1863 the difference between observation and calculation had risen to 33″ and 22″ in the two coördinates, and the theory evidently required revision in order to perfect the tables, on the one hand, to see if the discrepancies might arise from a trans-Neptunian planet. This is one of the four main problems proposed for solution by the author, the others being a new determination of the elements from the 40° already traversed by the planet in its orbit; a new determination of the mass of Uranus; and the construction of tables covering the dates from A. D. 1600 to 2000.

The formulæ for perturbations are developed in chapter II, and seven normal places from 1846 to 1863 are formed. Lalande's observation of 1795 receives a new and careful reduction, which shows it to differ from the adopted theory by

[1] Volume XV, first paper.

only 2″. 3 in longitude, 0″. 7 in latitude. The normals formed from modern observations differ about 0″. 3, which gives no support to the suspicion of a trans-Neptunian planet, although nothing is definitely settled, as a planet exterior to Neptune might exist and yet give small evidence of its attractions during the years 1795–1863. The standard system of star-places adopted is that of Gould. The mass of Uranus resulting from the discussion is $\frac{1}{21000}$. Observations with the great telescope in Washington (made by Newcomb in 1874 and later) give $\frac{1}{22600}$.

New elements of the planet are deduced, two of which may well be quoted here, viz.: Mean distance, 30.07055; periodic time, 164.782 Julian years.

THE ORBIT OF URANUS

PROFESSOR NEWCOMB'S "Investigation of the Orbit of Uranus," with tables of its motion, was published as No. 262 of the "Contributions to Knowledge" in 1873.

The work was undertaken as early as 1859, and the orbit of Neptune, just referred to, was a part of the general research.

The first chapter of the work is devoted to a method of development of the perturbations which is novel in many respects, and is especially suited to the particular problem in hand. With improved elements and methods the research was again begun in 1868, and carried to its termination in 1873, by the aid of the Smithsonian Institution and of the "American Ephemeris."

In the Report for 1872 Professor Newcomb presents some considerations on the scope of his researches, from which the following is taken.

"The first chapter of the work gives an exposition of the method employed in calculating the action of the disturbing planets Jupiter, Saturn, and Neptune on the motion of Uranus. In the second chapter this method is illustrated by quite a detailed calculation of the perturbations of Uranus produced by Saturn, including, however, only those which are of the first order with respect to the disturbing force. In the third, the perturbations produced by Jupiter and Neptune are given, but the computations are not presented with the same detail. The fourth chapter opens with a preliminary investigation of the orbit of Saturn, using Hansen's perturbations and the Greenwich observations, the object being the accurate determination of the terms of the second order. This is followed by the computation of the terms of the second order produced by Saturn, which includes those containing as a factor either the square of the mass of that planet or the product of its mass by that of Jupiter or by that of Uranus. The most remarkable of these terms is one of very long period, in which the results differ materially from those of other authorities, including Leverrier, Delaunay, Adams, and Hansen, who all agree among themselves. I cannot find any error in my work, and so must, of course, retain my own result, leaving it to future investigators to find the cause of the discrepancy. The difference is of such a nature that it cannot affect the computed position of the planet until after the lapse of more than a century.

"The sixth chapter gives a discussion of all the observations of Uranus which have been published and reduced in such manner as to be made use of. The entire number is 3763. The correction to a provisional theory given by each series of observations is deduced. The object of the seventh chapter is to apply such corrections to the elements of Uranus and the mass of Neptune that the observations shall be represented with the smallest possible outstanding errors. The mass of Neptune comes out $\frac{1}{19700}$, almost exactly the same as that found by Professor Peirce more than twenty years ago.[1]

[1] The mass of Neptune determined by Professor Newcomb's observations with the great telescope in Washington in 1874 and subsequently is $\frac{1}{19380}$. E. S. H.

The representation of the observations by tne concluded theory will probably be regarded as good. The mean outstanding difference during each five years since the discovery of the planet only exceeds a second of arc in a single instance — namely, during the years 1822-26, when it amounts to 1″. 4.[1]

"This agreement is very much better than any obtained before. Still, the vast number of observations used, and the care taken to reduce them to a uniform standard, led me to believe a better representation possible; and the outstanding differences, minute though they be, follow a regular law, thus showing that they do not arise from the purely accidental errors of observation. How far they arise from errors in my own theoretical computations, how far from the reductions of the observations themselves, and how far from the unavoidable errors of the instruments, I am unable to say without further investigation. It would be desirable to learn whether they may be due to the action of a trans-Neptunian planet, but to do this would require an entire re-reduction of all the older observations. Such a work is on many accounts an astronomical desideratum; but it could not be undertaken except under the auspices of the government.

"In the eighth chapter the general formulæ and elements are collected and expressed in the form most convenient for permanent use.

"The ninth, and concluding, chapter gives the tables by which the position of the planet may be computed for any time between the Christian era and the year 2300."[2]

Professor Newcomb's later works on planetary theory are mostly printed in the volumes of Memoirs printed by the "American Ephemeris."[3]

[1] The angular diameter of Uranus is about 4″. E. S. H.

[2] "Smithsonian Report," 1872, page 25.

[3] It is interesting to mention in this connection that Professor Newcomb was connected with the office of the "American Ephemeris and Nautical Almanac" from 1857 till 1897. He entered the United States Navy in the first named year as computor on the Almanac, and became its Superintendent in 1877, in which capacity he continued until his retirement.

VARIATIONS OF THE ORBITS OF EIGHT PLANETS

THE following summaries from the paper[1] itself will give an idea of its scope and of some of its principal results.

The reciprocal gravitation of matter produces disturbances in the motion of the heavenly bodies, causing them to deviate from the elliptic paths they would follow if they were attracted only by the sun.

The inequalities in the motions of the heavenly bodies are produced in two distinct ways. The first is a direct disturbance in the elliptic motion of the body, and the second is produced by reason of a variation of the *elements* of its elliptic motion. The elements of the elliptic motion of a planet are six in number—viz., the mean motion of the planet and its mean distance from the sun, the eccentricity and inclination of its orbit, and the longitude of the node and perihelion. The first two are invariable; the other four are subject to both periodic and secular variations. The periodic inequalities pass through a complete cycle of values in a comparatively short period of time; while the secular inequalities are produced with extreme slowness. The general theory of all the planetary inequalities was completely developed by Lagrange and Laplace nearly a century ago. Owing to the immediate requirements of astronomy, more attention has been bestowed upon the periodic than on the secular inequali-

[1] Stockwell, John N., "The Secular Variations of the Elements of the Orbits of the Eight Principal Planets, Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, with tables of the same; together with the obliquity of the ecliptic and the precession of the equinoxes in both longitude and right ascension," 1872, in Volume XVIII of the "Smithsonian Contributions to Knowledge." The expense of printing this paper was met by the gift of $1200 from Mr. Leonhard Case of Cleveland, Ohio, who preferred at that time that his name should not be mentioned.

ties, and in most researches it is sufficient to suppose that the latter sort vary uniformly with the time.

The demonstration that the secular inequalities of the planets are not indefinitely progressive, but are, in fact, themselves periodic, is due to Laplace, who showed that the elements of the planets will perpetually oscillate about their mean values, provided only that all the planets revolve round the sun in the same direction — as they do.

In order to calculate the limits of the variations of the elements with precision, it is necessary to know the correct values of the masses of all the planets.

The calculations of Lagrange (on the six planets known to him) were based on erroneous values of their masses. Pontecoulant's investigations (1834) did not improve our knowledge in this respect. Leverrier's researches (1839) on the seven planets then known are far from being exhaustive. The object of the present paper is to make as complete a determination of the variations of the elements of the eight planets of the system as is possible.

By the introduction of new methods of research the author has solved the problem in hand, and has obtained formulæ which will determine the secular variations of the planetary elements with less labor than would be necessary for the accurate determination of a comet's orbit.

Some of the conclusions derived may be briefly alluded to. The object of the investigation is to determine the numerical values of the secular orbits — namely, of the eccentricities and inclinations, and the longitudes of the nodes and perihelia, their values at any epoch, their rates of change, etc. A table at the end of the volume covering thirteen quarto pages gives these data, so far as they may be required by the astronomer in the prosecution of his work.

A similar tabulation of the elements of the earth's orbit of

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sufficient extent to be useful in extended geological investigations does not come within the scope of the work. The nature of the results arrived at may be illustrated by quoting a paragraph regarding the planet Mercury.

"For the planet Mercury, we find that the eccentricity is always included between the limits 0.124923 and 0.2317185. The mean motion of its perihelion is 5″.463803; and it performs a complete revolution in the heavens in 237,197 years. The maximum inclination of its orbit to the fixed ecliptic of 1850 is 10° 36′ 20″, and its minimum inclination is 3° 47′ 8″; while with respect to the invariable plane of the planetary system, the limits of inclination are 9° 10′ 41″ and 4° 44′ 27″. The mean motion of the node of Mercury's orbit on the ecliptic of 1850 and on the invariable plane is in both cases the same, and equal to 5″.126172, making a complete revolution in the interval of 252,823 years. The amount by which the true place of the node can differ from its mean place on the ecliptic of 1850 is equal to 30° 8′, while on the invariable plane this limit is only 18° 31′."

A knowledge of the elements of the earth's orbit is especially interesting and important on account of the recent attempts to establish a connection between geological phenomena and terrestrial temperature, in so far as the latter is modified by the variable eccentricity of her orbit. The amount of light and heat received from the sun in the course of a year depends to an important extent on the eccentricity of the earth's orbit; but the distribution of the same over the surface of the earth depends on the relative position of the perihelion of the orbit with respect to the equinoxes, and on the obliquity of the ecliptic to the equator. These elements are subject to great and irregular variations; but their laws can now be determined with as much precision as the exigencies of science may require. A table of the eccentricity

of the earth's orbit for every 10,000 years during a period of 2,000,000 years is given. The equinoxes perform a revolution in the average interval of 25,694.8 years. The maximum variation of the tropical year is now shorter than in the time of Hipparchus by 11.30 seconds. The mean value of the obliquity is $23° 17' 17''$, and the limits are $24° 35' 58''$ and $21° 58' 36''$. A paragraph on the advantages we derive from a spheroidal earth contains highly interesting conclusions too long to be quoted here.

The duration of the different seasons is also greatly modified by the eccentricities of the earth's orbit. At present the sun is north of the equator scarcely 186½ days, and south of it 178¾ days.

In the past history of the earth these periods have been changed so as to give a summer, in one hemisphere, of 198¾ days, and a winter of only 166½ days. The variations of the sun's distance from the earth in the course of a year, at such times, are also enormous, amounting to almost one-seventh part of its mean distance—a quantity scarcely less than 13,000,000 miles.

The foregoing illustration of a few of the results of this memoir will show the far-reaching nature of the problems with which it deals, and perhaps of others, of no less importance, which it suggests. Its introduction of eighteen pages presents these problems in a clear light.

HARMONIES OF THE SOLAR SYSTEM

In this paper,[1] which is printed in the "Contributions," Professor Stephen Alexander seeks to set forth certain numerical relations between the distances of the planets and

[1] "Statement and Exposition of Certain Harmonies of the Solar System," 1875; in Volume XXI of the "Smithsonian Contributions to Knowledge," first paper.

satellites, and devotes special sections to a modification of the nebular hypothesis of Laplace, and to a modification of Jones's theory of the zodiacal light. The memoir concludes with a summary of the coincidences between theory and fact.

COMETS

In the early years of the activity of the Institution the discovery of comets was rewarded, or, as it is better to say, commemorated, by the award of a gold medal founded by the King of Denmark.

Miss Maria Mitchell, of Nantucket,[1] discovered a comet on October 1, 1847, which was independently discovered in Europe by Da Vico (October 3), Dawes (October 7,) Madame Rumker (October 11), and which was known as Da Vico's comet for some time, owing to the slow mails of those days.

To mark the fact of her discovery, the Institution gallantly awarded a premium to Miss Mitchell, but the precedent so set was not followed in subsequent discoveries by her male rivals — Bond, Van Arsdale, Tuttle, and others. Miss Mitchell subsequently became a computer for the "American Ephemeris," and the gallantry was continued by assigning to her all the calculations relating to the planet Venus. The account of Miss Mitchell's discovery is given in the second volume of the "Contributions."

COMET-ORBITS

In the Report for 1862 is a most interesting letter from Professor Hubbard, of the Naval Observatory, describing his

[1] Miss Mitchell was professor of astronomy in Vassar College from 1865 till 1889.

researches on the orbit of Biela's comet for its six recorded appearances from 1772 to 1852, and asking for the aid of the Institution in calculating the perturbations over the whole interval from 1772 to 1865 (the next appearance), so as to unite, in a single theory, all the observed places of the comet.

Professor Henry's printed note on this letter highly commends the project of Professor Hubbard, but indicates that the assistance desired could not be given at that time. Some assistance was, I believe, subsequently given. At any rate, astronomers have fully appreciated Hubbard's work on this comet, which was printed in the early volumes of the *Astronomical Journal.*

The Report for 1874 contains a notice of a work of the same sort on the periodic comet of Tuttle (period 13.7 years), which was done by Professor Ormond Stone and assistants at the cost of the Smithsonian Institution. A careful computation of the perturbations from 1871 to 1885 served as the basis for an ephemeris of the comet during its appearance in 1885 (published in Circular No. 1 of the McCormick Observatory), and the orbit is now in charge of Doctor Rahts, of the Observatory of Königsberg.

ORBIT AND PHENOMENA OF A METEORIC FIRE-BALL

THE "Contributions to Knowledge" contain a paper[1] by Professor James H. Coffin with the title given above. This great fire-ball was visible about 10 P. M. from Lake Michigan to a point at sea southeast of the island of Nantucket,—a distance of 1300 miles. The observed path of the meteor was its orbit with respect to the earth as a center of

[1] "The Orbit and Phenomena of a Meteoric Fire-Ball seen July 20, 1860," in Volume XVI of the "Smithsonian Contributions to Knowledge, 1869."

attraction. The velocity in the (hyperbolic) orbit was 9¾ miles a second, approximately. As the meteor moved in its path, successive explosions took place, and it was found to be necessary to divide the orbit into three parts and to determine three sets of elements corresponding to the parts. The perigeal distances in the three sections were, for example: 40,007 miles, 3974 miles, 3995 miles, respectively, The meteor's nearest approach to the earth's surface was about 39 miles, which point corresponds to the end of the second section of its path. From this point onwards its height above sea increased. One of the employees of the United States Lake Survey describes the meteor (near Lake Huron) to have been nearly as large as the moon, at first. In a moment it had burst and a piece "fell directly to the ground near the place of observation, setting fire to the vegetable matter around it; the fire was put out, but the piece could not be found." In Washington City the meteor was observed as two bodies near together, "each as bright as Venus when close to the earth." Its rate of motion was comparatively slow, so that one observer in New Jersey wrote: "The movement of the meteor appeared to be not much more rapid than the flight of an eagle I think I could have kept sight on it with a gun throughout its course."

In reading the various reports from persons scattered over the Middle and Western States, it is remarkable to note the names of the observers. An extraordinarily large proportion of these names are well known to all Americans. All the astronomers—Young, Bond, Peters, Bartlett, Mitchel, Lyman, Newton, Swift, and others—appear to have seen it; there are reports from many professors in colleges; and a great number of the remaining observers are well known in one way or another. It is seldom that the data for such an orbit are derived from reporters of such trained intelligence.

METEORITES

THE Institution has paid great attention to the formation of a collection of meteorites and to the gathering of accurate information regarding the circumstances of their fall.

It is an instructive proof of the wide influence of the Institution to note that all phenomena of this kind are promptly reported to its Secretary. The first thought of observers of all classes is to communicate with the Smithsonian Institution, and this is also an excellent witness to the general intelligence of the country, as has been remarked by all who have had occasion to observe how widely this desire is spread and in what unexpected places it is found.

STAR-MAPS

A COMMITTEE of the Connecticut Academy of Sciences, Professor H. A. Newton, Chairman, prepared a large and very convenient star-map of the north polar regions to aid in the observations of the August meteors, which was widely circulated at the expense of the Smithsonian Institution; as well as a copy of the smaller map, from the Toronto observations, designed for observations of the aurora. Many observers took part in the charting of meteors, and their results have been discussed and published by Professor Newton and others in various journals.

TRANSLATION OF GAUSS'S "THEORIA MOTUS"

GAUSS's monumental work, "Theoria Motus Corporum Cœlestium," was printed, in Latin, in the year 1809. The first German translation of it was not published until 1865. In the hope of familiarizing American students with the new

methods, Admiral C. H. Davis, then Superintendent of the "American Ephemeris," undertook an English translation, which was finally published by the firm of Little & Brown, publishers, of Boston, in 1857.

The expense of the publication was shared by the Institution, and a number of copies were subscribed for as exchanges and distributed in exchange for other books among foreign correspondents. Without this aid, the work, so essential to the advance of practical astronomy, could not have been issued.

TABLES FOR DETERMINING PERTURBATIONS OF PLANETS

In determining the mutual action of any two planets in the solar system, there are certain quantities depending upon the ratio of the mean distances of these bodies from the sun, which must first be computed. The number of these quantities, and the labor necessary to compute each one of them, make this first step in the reduction of the mutual action of the two planets to numbers a serious work. The tables[1] published by the Institution and calculated by Professor J. D. Runkle, accomplish in a very satisfactory way the desired end of shortening the calculations referred to. Their use gives practically the same advantage in the computations to which they are applied that is afforded in arithmetical operations by a table of logarithms. The tables and the supplements contain the quantities which relate to the major planets and to the asteroids also.

It is proper to add that the general theory, thus reduced to numbers, is due to Leverrier; and that Walker had previously printed (in an appendix to the "American Ephemeris" for 1857) a tabulation of the Leverrier coefficients.

[1] "New Tables for Determining the Values of the Coefficients in the Perturbative Function of Planetary Motion, which depend upon the ratio of the mean distances," 1856, in Volume IX of the "Smithsonian Contributions to Knowledge," fifth paper.

ON THE GENERAL INTEGRALS OF PLANETARY MOTION

THIS paper,[1] on mathematical astronomy, is, in part, an extension and generalization of two former papers by Professor Newcomb, and is too strictly technical to allow of any short account of its thesis in this place.

ASTRONOMICAL EXPEDITION TO CHILE

IN the years 1849-1852 an expedition under Lieutenant Gilliss, of the United States Navy, was resident in Chile, engaged in various researches which required the coöperation of Northern and Southern observatories.

The Congress of the United States appropriated the sum of $5000 to its use, but this amount was not sufficient to provide all the necessary instruments. Accordingly, the Smithsonian Institution stepped forward in 1849 to supply the need with the gift of $2000 to purchase an equatorial telescope, and in 1850 with a gift to supply an astronomical clock and chronograph.

Congress subsequently appropriated funds to cover their cost, but the prompt action of the Institution saved a year to the observers. It is interesting to remark that the instruments were subsequently purchased by Chile, and set up in Santiago in a National Observatory, the first in South America. The National Observatory of the Argentine Republic in Cordoba was also founded by an American, Doctor B. A. Gould, in 1870.

This is not the place to write the history of the astronomical expedition to Chile, honorable as it was to the country and to Gilliss himself. It may be found in the report of the

[1] "On the General Integrals of Planetary Motion," 1874. It forms the second paper in Volume XXI of the "Smithsonian Contributions to Knowledge."

expedition, and, in a briefer form, in the éloge of Gilliss prepared by Gould for the National Academy of Sciences.[1]

Doctor Gould remarks that this expedition of Lieutenant Gilliss is noteworthy in the history of the country as the first instance of deference by the legislative and executive authorities of the nation to the views of the organized representatives of science within its borders. The appropriation by Congress was made because Gilliss's plans were approved by the American Philosophical Society and by the American Academy of Arts and Sciences.

Again, the first refracting telescope of any considerable size made in America was constructed for use in Chile — namely, a six-inch telescope by Mr. Henry Fitz. The cost of the objective was $500.

Gilliss's assistants were officers of the Navy — Messrs. MacRae and Hunter, and subsequently Mr. Phelps.

A summary of the work accomplished may fittingly terminate this brief notice.

"Between the 6th of December, 1849, and the 13th of September, 1852, series of micrometric comparisons of Mars were made on forty-six days during the first and ninety-three days during the second apposition, and micrometric comparisons of Venus on fifty-one days during the first and twenty-seven days during the second inferior conjunctions; the observations on each day being continued through several hours, whenever the sky permitted." By a woeful lack of coöperation on the part of Northern observatories, this work of Gilliss's was rendered useless.

Fortunately for science, and happily for Gilliss, his observations were not limited to those which it was his special duty to make. Even these on Mars and Venus, which failed of their deserved fruit in affording those data they were in-

1 "Biographical Memoirs," Washington, 1877, Volume I, page 162.

stituted to obtain, are yet of priceless value in the means they afford for improving our knowledge of the orbits of our two neighboring planets.

Among other astronomical fruits of the expedition to Chile I may mention the following: 7000 meridian observations of 2000 stars. These, with their instrumental and tabular reductions and a resultant catalogue, form a part of Volume IV of the series of the results of the expedition.

Equal, if indeed not superior, in value to these are the 33,000 observations of about 23,000 stars within $24\frac{1}{5}°$ of the South Pole. These comprise stars to the 10th magnitude inclusive, more than 20,000 of which had not been previously observed.

Observations of earthquakes (124 shocks in three years), a very extended series of meteorological observations, and systematic observations of magnetism make another chapter of results to the credit of the expedition.

ASTRONOMICAL OBSERVATIONS IN THE ARCTIC SEAS

THE famous expeditions of Doctor Kane to the Arctic, in the years 1853–54–55, yielded astronomical results of value, which were discussed by Charles A. Schott and printed by the care of the Institution.

The observations are chiefly useful in fixing geographical positions on the chart of the expedition up to latitudes 81° and 82°. Meteorological, magnetic, and tidal observations of great value were also secured, and similarly discussed and published; and the scientific results of the expedition are most satisfactory when the immense difficulty of work under such abnormal conditions is kept in view.

The Arctic expeditions of Hall and Hayes were aided, in many respects, by the Smithsonian Institution, and the astro-

nomical observations of the former expedition made by Doctor Emil Bessels, were all reduced in Washington.

TRANSATLANTIC LONGITUDE

THE determination of longitude[1] by telegraph was, as is well known, first practised by American astronomers. The difference of longitude between Baltimore and Washington was fixed, in 1844, by Captain Wilkes, who compared his chronometer at Baltimore with signals received from Washington. Professor Sears C. Walker in 1845, and subsequently, put the telegraphic methods into practical form, and they were soon adopted as the work of a regular department of the Coast Survey, with the cordial support of Professor A. D. Bache, the Superintendent. Professor Loomis was a coadjutor of Walker in this work; and subsequently the longitude service of the Survey was under the direction of Doctor B. A. Gould, who improved it in many respects. By the efforts of these astronomers, aided by the chronographs lately invented by Bond and Mitchel, and by devices due to Saxton and others, the methods of observation were brought to a high degree of accuracy. The observations themselves were reduced by rigorous methods.

From 1846 to 1861, the date of the beginning of the Civil War, the telegraphic determinations of longitude had followed the extension of the commercial lines of wire until, in the latter year, they extended from the northeastern boundary of the United States to New Orleans, covering 2½ hours of longitude and 15° of latitude. The problem of the connection of American with European longitude was on a different footing. Until the Atlantic cable was available the ocean lon-

[1] Gould, Benjamin A., "The Transatlantic Longitude as determined by the Coast Survey Expedition of 1866." This memoir was published in 1869 and forms the sixth paper in Volume XVI of the "Smithsonian Contributions to Knowledge."

gitude depended on less exact methods. The following table, abridged from Doctor Gould's memoir, gives the differences of longitude:

GREENWICH OBSERVATORY—WASHINGTON OBSERVATORY, AS DETERMINED BEFORE 1866.

From Occultations and Eclipses.

		H.	M.	S.
Walker:	From his observations before 1843.	5	8	11.14
Peirce:	From the eclipse of 1851.			11.57
Peirce:	From emersions of the Pleiades, 1839			11.45
Peirce:	From emersions of the Pleiades, 1856–61 . .			13.13

From Lunar Culminations.

		S.
Walker:	From Cambridge observations, 1843–45.	10.01
Loomis:	From Hudson observations, 1838–44	9.03
Gilliss:	From Capitol Hill observations, 1838–42	10.04
Newcomb:	From Washington observations, 1846–60	11.06
Newcomb:	From Washington observations, 1862–63	9.08

From Transportation of Chronometers between Boston and Liverpool.

		S.
Mean from 373 chronometers previous to 1849		12.52
Bond:	From 175 chronometers, 1849	11.20
Walker:	From 175 " 1849	12.06
Bond:	From 175 " 1849	12.26
Bond:	From 52 " 1855	13.49

The Superintendent of the Coast Survey, Professor A. D. Bache, determined to take advantage of the Atlantic cable as soon as practicable, and plans for a longitude campaign were made by Doctor Gould.

The methods employed on land lines required serious modifications in the transatlantic work, and even the Canadian land-lines (Calais, Maine, to Heart's Content, in Newfoundland), could not be worked according to the methods usual in the Survey. The Astronomer-Royal, Professor Airy, had intended to make a transatlantic longitude campaign in June, 1867; but with his characteristic devotion to science, he en-

tered into the Coast Survey campaign as if it were his own. The steps of the program determined the longitudes.

	H.	M.	S.
I. Greenwich–Foilhommerum (Ireland)	0	41	33.29
II. Foilhommerum–Heart's Content (cable)	2	51	56.54
III. Heart's Content–Calais (Maine).	0	55	37.72
Greenwich–Calais	4	29	7.55

or, after correcting for a slight error first pointed out by Dr. A. Wagner,[1] the result is —

	H.	M.	S.
Greenwich–Calais	4	29	7.62

The numbers given above are the result of observations at five stations, and by the observers Dunkin and others (at Greenwich), Gould and Morgan (Foilhommerum), Dean and Goodfellow (Heart's Content), Davidson and Chandler (Calais), Boutelle (Calais). It was not possible to eliminate the personal equations of these observers by interchanging stations, and the observations for determining the corrections on this account lead to quite anomalous results, entirely at variance with the past experience of the observers.

The personal equations actually employed in the reductions were obtained by assuming them to have such values as bring the various steps of the program into the best accordance. In the table below, column A gives the personal equations as determined by observation, while column B gives the values actually employed in the reductions:

	A *Observed.* S.	B *Adopted.* S.
Gould-Mosman	+0.45	+0.02
Dean-Mosman	+0.12	+0.11
Goodfellow-Dean	+0.03	+0.02
Boutelle-Goodfellow	−0.13	−0.14
Boutelle-Chandler	−0.22	−0.04
Dunkin-Gould	unknown.	unknown.

1 *Vierteljahrschrift der Astronomischen Gesellschaft*, 1871, page 136.

The longitude Calais-Washington depended upon the steps Calais-Bangor, Bangor-Cambridge, Cambridge-New York, New York-Washington, and the final result of the campaign gives Greenwich-Washington 5 h. 8 m. 12.39 s., or, corrected by Wagner, 5 h. 8 m. 12.46 s. It appears that the chronometer expeditions by Bond gave the result nearest to the determination by cable.

A second campaign was made by Mr. Dean in 1866 over the French cable from Brest to Duxbury, Massachusetts, and a third campaign in 1872, which connected the observatories of both Greenwich and Paris with the United States, and therefore incidentally gave the earlier telegraphic difference of longitude between these observatories. The resulting longitude Greenwich-Washington was 5 h. 8 m. 12.09 s., which is the value now adopted (1896).

The expedition of 1866 was conducted under unfavorable circumstances, and was not entirely satisfactory in all its parts. It was, however, the first attempt of this sort, and the first demonstration that such determinations could be successfully carried out in the face of new and peculiar difficulties. The expeditions of 1870 and of 1872 followed the path traced out by Doctor Gould and his associates in 1866, and the results of the three expeditions taken together are a substantial addition to geodesy and astronomy.

SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN

THE geographical and geological surveys of the region of the United States west of the one hundreth meridian, under Major Powell, Doctor Hayden, and Lieutenant Wheeler, respectively, were necessarily forced to pay much attention to the determination of geographical positions. In one way or another the Smithsonian Institution has forwarded their work

in this respect and in others, and at least a passing record of its service should be made in this place.

ANNOUNCEMENTS OF ASTRONOMICAL DISCOVERIES

In 1871, Doctor C. H. F. Peters, Director of the Hamilton College Observatory, addressed a letter to the Secretary of the Smithsonian Institution, asking that the Institution should act as a central office for communicating by telegraph discoveries of planets and comets. Steps were immediately taken by Professor Henry to arrange for such service, and from 1873 to 1883 it was carried out under the auspices of the Institution.

Great pains were taken by Professor Henry and Professor Baird to obtain the opinions of astronomers as to the best form of message.

These telegrams were useful to American science, in spite of many errors which arose mainly from the fact that the Institution had no astronomer to serve as critic and editor. The telegrams received by the Institution from discoverers were very often wrongly worded, and there was no control.

These telegrams were widely disseminated by Associated Press despatches; and in a more detailed and scientific form by the circulars of the Boston Scientific Society, edited by Mr. John Ritchie, from 1879 onwards. Mr. Ritchie and Doctor S. C. Chandler, in 1881, devised a special cipher-code for transmitting such telegrams, which was submitted to, but not accepted by, the Smithsonian Institution. During 1882–1883 arrangements were concluded which resulted in the transfer of this service to the Harvard College Observatory.[1]

[1] See the "Smithsonian Report," 1883, page 33, and *The Science Observer*, Volume IV, page 33 (1883), for the contemporary and official records of this transfer. See also *The Astronomical Journal*, Volume VI, page 189 (1888), and *The Publications of the Astronomical Society of the Pacific*, 1896, Volume VIII, pages 109 and 179.

Mr. Ritchie was appointed to take charge of this department of the Observatory work, and Doctor Chandler calculated comet orbits, ephemerides, etc., for quick transmission to other observatories. The transfer of the Bureau of Astronomical Telegraphy from the Smithsonian Institution to the Harvard College Observatory was in exact conformity to the settled policy of the former establishment, which is to relinquish its own work to other responsible institutions so soon as the latter are willing and competent to undertake it.

Under the new arrangement astronomers are sure of receiving early warnings of the appearance of a new comet, etc., and orbits and ephemerides can now be quickly computed and distributed. To any one who recollects the state of such matters previous to 1873, the improvement is most striking. It is due to the original suggestion of Doctor Peters, to its prompt adoption by the Smithsonian Institution, to the subsequent devices and editorship of Messrs. Chandler and Ritchie, and to the assumption of the necessary expenses by the Harvard College Observatory.

The present astronomical service of Europe, under Professors Krüger and Kreutz, of the Observatory of Kiel, is exceedingly prompt, able, and useful.[1]

EQUATORIAL OF HAMILTON COLLEGE OBSERVATORY

This telescope, which in 1856 was the largest ever constructed in America — now the land of large telescopes — was made for Hamilton College by Charles A. Spencer. The trustees of the College officially requested the regents of the Smithsonian Institution to appoint a committee of experts to report upon the instrument; and the reasons alleged by the

[1] Similar European telegrams were formerly distributed by the Vienna Academy of Sciences, according to a code devised by Professor Karlinski, of Cracow, in 1865. (*Astronomischen Nachrichten*, Volume LXVI, column 31; Volume LXXV, column 141.)

trustees for the request are interesting as showing the universal confidence which the Institution had already conquered. The following quotations will make this point clear.

"*Again*, the funds for the construction of this instrument, and the Observatory to which it is attached, were contributed by many persons interested in the advancement of science, and scattered throughout the State of New York. To these persons our Institution pledged itself to secure a first-class instrument. The college corporation desires to satisfy them by an announcement from an authoritative quarter that it has faithfully fulfilled the trust, etc.

"Furthermore, . . . the undersigned, in behalf of the College, would be glad to establish a precedent, which might lead the purchasers of other astronomical instruments to submit the question of their proper construction to your body, as being an institution central in its position and national in its character."

The appointment of the Committee called for was one of the early precedents for the service of officers of the Smithsonian Institution on boards and councils, in which their work has been of very wide usefulness.

CORRECTION OF SEXTANTS FOR ERRORS

A PAPER [1] on the above subject was published in 1890. It represents the results of thirty years' experience on the part of its author, Mr. Joseph A. Rogers. The paper has two main objects, the first being to set forth simple and practical methods by which an observer may determine the errors of any particular sextant; the second, and perhaps more important, object being to point out to observers generally how

[1] "The Correction of Sextants for Errors of Eccentricity and Gradation." It was published in 1890, in Volume XXXIV of the "Smithsonian Contributions to Knowledge."

observations with any sextant may be made exceedingly accurate by careful handling, and by the application of the corrections named above, and thus to create among observers and instrument makers a higher standard of work and a consequent improvement in processes of manufacture.

CONSTRUCTION OF A SILVERED-GLASS TELESCOPE

DOCTOR HENRY DRAPER published in 1864, through the medium of the Smithsonian Institution, a description of his construction of a telescope that has become a text-book for those engaged in the making of silver-on-glass reflectors.[1]

The reflector has in some special researches, as in photography and in some parts of celestial spectroscopy, a distinct advantage over the refractor; and as the aperture increases, the difference in cost between a reflector and a refractor of the same size is very marked.

There is somewhere a limit to the size of a refractor due to the fact that the incident light increases only as the square of the aperture, while the absorption of the light in passing through the glass increases in a far higher ratio. The ratio of focus to aperture in large refractors must be relatively large (in the Lick refractor it is 19 to 1). On the other hand, large reflectors can be built of relatively short focus (in the Crossley reflector of the Lick Observatory the ratio of focus to aperture is about 6 to 1), and they can be constructed at small cost, and mounted,— since they are comparatively short,— in relatively small domes. They are very sensitive to changes of temperature and to mechanical flexures, and for these and other reasons large reflectors are often inferior in definition to refractors of equal aperture. But where, as

[1] "On the Construction of a Silvered-Glass Telescope, 15½ Inches in Aperture, and Its Use in Celestial Photography." It was published in 1864, and is the third paper in Volume XIV of the "Smithsonian Contributions to Knowledge."

in spectroscopy, the definition is the secondary and the amount of light collected the primary consideration, large reflectors will have the advantage. If the difficulties due to temperature, flexure, etc., are overcome, the reflector has another advantage in that the rays of all wave-lengths are brought to a single focus, which is not the case for the refractor. This constitutes a marked advance in certain fields of celestial photography.

In 1857 Doctor Draper visited Lord Rosse's observatory at Parsonstown, and was privileged to see the operations of grinding and polishing mirrors of speculum metal. In 1858 he began the construction of a 15-inch speculum in America. In 1860 speculum-metal was abandoned for silver-on-glass. During 1861 three mirrors were constructed of 15½ inches aperture, and others smaller. In 1862 Doctor Draper was with his regiment in the Virginia campaign; but in the winter of that year two 15½-inch and two 9-inch mirrors were completed. The greater part of the year 1863 was devoted to lunar and planetary photography and to the enlargement of focal negatives.

The various practical processes required for the manufacture of a perfect mirror are described in detail and at length. These descriptions are of the highest value, for they embody the results of long practical experience described by an observer of adequate theoretical knowledge. The first of these sections relates to experiments on a metal speculum. The next section refers to silvering the glass, and contains many practical hints. It is interesting to note that the film of silver is about $\frac{1}{200000}$ of an inch in thickness, and of the same optical figure, therefore, as the glass surface. Its thinness can be expressed in a striking form by remarking that the value of the silver on a 15½-inch mirror is not above one cent. The durability of these films (when kept free from

sulphuretted hydrogen) is much greater than one might think. Grinding and polishing glass are treated in several sections also. Rolled glass, such as was used for speculums, has axes of rigidity, which must be considered in mounting the mirrors. The effects of heat in deforming the image formed by a reflecting surface are next studied. The grinding-tools and the emery used with them are described, and, again, many points of practical value are brought out. The method of testing the optical surface is fully explained in detail. A section of the paper is devoted to the description of grinding-machines of various kinds. This is followed by sections relating to eyepieces, plane mirrors, telescope-mounting (altazimuth), moving plate-holders for photographs, driving-clocks, cameras, the construction of an observatory, observing chair, the photographic laboratory, enlarging apparatus, microscopic photography, and the like.

In each and all of these sections, it is clear to the reader that he is obtaining the results of first-hand experience acquired not by one but by many trials.

After completing the 15½-inch mirror, Doctor Draper constructed a 28-inch Cassigranian reflector, which he mounted equatorially (on a stand constructed by himself) alongside of an 11-inch photographic refractor by Alvan Clark & Sons. The reflectors were at first employed in producing a large number of excellent photographs of the moon, and later in researches in stellar spectroscopy.

Since Doctor Draper's too early death these and other instruments have been presented by Mrs. Draper to the Harvard College Observatory. A large annual grant of money is made by Mrs. Draper for the continuation and extension of the researches begun by her husband, and under the skilful direction of Professor Pickering, the publications of the Draper Memorial have already been of high value to science. The

sound theoretical knowledge of Doctor Draper, and his very extended experience in certain fields, are nowhere better exemplified than in the memoir, of which only a brief summary can be given.

PENDULUM OBSERVATIONS

THE building of the Smithsonian Institution was early chosen as a suitable station for the determination of the force of gravity, and it has been used by the officers of the Coast Survey (Charles S. Peirce, Erasmus D. Preston, Edwin Smith, and others) and by foreign scientists for this purpose.

AID TO "THE ASTRONOMICAL JOURNAL"

IN the year 1849, Doctor B. A. Gould began the publication of *The Astronomical Journal*, a periodical devoted solely to the interests of astronomy, and issued always at a loss. From the first the Institution has subscribed for a number of copies, which are regularly distributed to foreign correspondents, and this original subscription is still continued.

BIBLIOGRAPHIES OF SCIENTIFIC LITERATURE

THE following bibliographies relating to astronomy and astrophysics have been published by the Institution.

"Index Catalogue of Books and Memoirs relating to Nebulæ and Clusters, etc.," by Edward S. Holden (1877), in "Smithsonian Miscellaneous Collections," Volume XIV.

"A Synopsis of the Scientific Writings of Sir William Herschel," prepared by Edward S. Holden and Charles S. Hastings, in the Smithsonian Report for 1880.

"Index to the Literature of the Spectroscope," by Alfred Tuckerman (1888), in the "Smithsonian Miscellaneous Collections," Volume XXXII.

"Bibliography of the Chemical Influence of Light," by Alfred Tuckerman (1891), in "Smithsonian Miscellaneous Collections," Volume XXXIV.

"Bibliography of Astronomy for 1887," by William C. Winlock, in "Smithsonian Miscellaneous Collections," Volume XXXIV.

"The Index Catalogue of Nebulæ, etc.," includes papers, memoirs, and books on nebulæ and clusters alphabetically arranged according to authors, with a brief note to each entry expressing its contents. The works of the elder Herschel on these subjects are analyzed at considerable length, in order to partly supply the great want of an edition of his collected works. The index is practically complete to 1877, and comprises 110 octavo pages. The astronomical life of Sir William Herschel covered forty-two years. During this period he published no less than sixty-nine different memoirs, which are scattered through the annual volumes of the *Philosophical Transactions of the Royal Society of London* from 1780 to 1818. In the absence of an edition of Herschel's collected works, Doctors Holden and Hastings have carried out the idea of making a full synopsis of every one of his memoirs according to a model which he himself made for one of his most important papers.[1] Accordingly his memoirs on astronomical subjects have been analyzed, page by page, by Professor Holden, and those on physics have been treated in the same manner by Doctor Hastings. The work (of 114 octavo pages) supplies, in some measure, the crying need for a complete edition of his writings.

Doctor Tuckerman's "Index to Spectroscopic Literature" is a stout volume of 424 octavo pages, comprising references to 3829 papers by 799 authors. The astronomical portion

[1] *Philosophical Transactions of the Royal Society of London*, 1811, Volume CI, part I, page 269.

of the bibliography is given in pages 66 to 133, and is subdivided into 45 sections, as comets, stars, meteors, eclipses, etc. An author-index, pages 363 to 394, is an admirable complement to the index by subjects.

"The Bibliography of the Chemical Influence of Light," by Doctor Tuckerman (22 octavo pages) should be mentioned among astronomical bibliographies, as it gives the scientific bases of photography.

An index to the literature of photography is (1891) in preparation by the same author. The two works, taken together, will be of the greatest use in connection with the application of the art of photography to astronomical researches.

SHORT PAPERS ON ASTRONOMICAL SUBJECTS

In the early years of the Institution it was part of the plan to provide for popular lectures on scientific subjects during the sessions of Congress by distinguished specialists.

Among these lectures we may mention six on the "Progress of Astronomy," by Doctor B. A. Gould, and one by Professor S. Alexander, on the "Relations of Space and Time" (both referred to, but not printed, in the Smithsonian Report, 1854); one by Professor E. S. Snell, on "Planetary Disturbances" (Smithsonian Report, 1855); and lectures on "Astronomy," by Professor Alexis Caswell (Smithsonian Report, 1858).

The plan of regular lectures was not systematically maintained in subsequent years. They were replaced by popular papers on scientific topics, either original or transferred from other periodicals. In looking over the Reports in the Library of the Lick Observatory (not quite a complete set) I have found the following references to papers of the sort. This list may not be exhaustive:

AUTHOR.	SHORT TITLE.	YEAR.	PAGE.
Charles Smallwood	Description of His Observatory	1856,	311
L. W. Meech	Heat and Light of the Sun	1856,	321
Auguste Laugel	On the Sun	1861,	175
John Lee	On Astronomical Photography	1861,	191
Charles Dufour	Scintillation of the Stars	1861,	220
R. Gautier	On the Nebulæ	1863,	299
J. Fourier	Éloge of Delambre	1864,	125
Charles Delaunay	The Velocity of Light	1864,	135
J. Lamont	Solar Eclipse of 1860	1864,	240
William Huggins	Spectrum Analysis	1866,	195
	Appearance of the Sun's Disk	1866,	209
Élie De Beaumont	Memoir of Legendre	1867,	137
Cleveland Abbe	Dorpat and Poulkowa	1867,	370
G. Hagen	Memoir of Encke	1868,	193
Joseph Henry	Eulogy on Bache	1870,	91
François Arago	Biography of W. Herschel	1870,	197
N. S. Dodge	Memoir of John Frederick William Herschel	1871,	109
John N. Stockwell	On Secular Variations of the Planetary Orbits	1871,	261
Benjamin A. Gould	The Cordoba Astronomical Observatory	1873,	265
François Arago	Eulogy of Laplace	1874,	129
Ed. Mailly	Eulogy on Quetelet	1874,	166
William B. Taylor	Kinetic Theories of Gravitation	1876,	205
Daniel Kirkwood	The Asteroids between Mars and Jupiter	1876,	358
Sanford C. Fleming	Time-Reckoning for the Twentieth Century	1886,	345
R. Radau	Astronomical Photography	1889,	469
Robert Simpson Woodward	Mathematical Theories of the Earth	1890,	183
Hubert A. Newton	Memoir of Loomis	1890,	742
William Huggins	Celestial Spectroscopy	1891,	69
Agnes M. Clerke	Stellar Numbers and Distances	1891,	103
	The Sun's Motion in Space	1891,	109
	A Southern Observatory	1891,	115
Charles S. Hastings	History of the Telescope	1892,	95
Sir Robert S. Ball	Wanderings of the North Pole	1893,	75
A. C. Ranyard	The Lunar Crater Tycho	1893,	89
Charles A. Young	Variable Stars	1893,	107
Sir George G. Stokes	The Luminiferous Æther	1893,	113
William Harkness	Magnitude of the Solar System	1894,	93
William H. Pickering	Schiaparelli's Views on Mars	1894,	113
J. Janssen	Photographic Photometry	1894,	191
John K. Rees	Variation of Latitude	1894,	271

ANNUAL REPORTS ON THE PROGRESS OF ASTRONOMY

UNDER the editorship of Professor S. F. Baird the firm of Harper & Brothers, of New York, published a "Record of Science and Industry" from month to month in "Harper's Magazine," and as an annual volume from 1871 to 1878. The articles relating to the progress of astronomy were written by Professor Cleveland Abbe till 1875, and for the years 1876, 1877, and 1878 by Doctor Edward S. Holden.

From the year 1879 onwards this record of the progress of astronomy was printed in the annual Report of the Smithsonian Institution, the articles for the years 1879 to 1885 being written by Doctor Holden, and from 1885 to 1892 by Mr. William C. Winlock, of the Institution.

In 1879 a circular was prepared by Doctor Holden and sent by the Smithsonian Institution to different observatories. The answers to this circular gave valuable information as to the instrumental equipment of the different establishments, as to their past work and that proposed for the future, etc., and were printed in the Reports for 1879 (edited by Doctor Holden) and for 1886 (edited by Mr. George H. Boehmer).

The inevitable limitations of space and the necessary omission of technical considerations made all these annual reviews very unsatisfactory to their compilers; but, after taking much pains to be correctly informed, it is my opinion that they have been of considerable value to unscientific readers, and of some slight, though real, convenience to astronomers. The "Bibliography of Astronomy" for the year 1888 (printed in the Report for 1888), by Mr. Winlock, was an attempt to vary the form in which astronomical information should be given. In this case the essential benefit was to professional astronomers and librarians.

CHEMISTRY

By Marcus Benjamin

Fellow of the Chemical Society of London

THAT James Smithson was an analytical chemist of no mean ability has been shown elsewhere in this volume, but it is eminently proper to emphasize that fact in connection with this summary of chemistry, by the repetition of the statements that while a student in Oxford he had "the reputation of excelling all other resident members of the University in the knowledge of chemistry," and that later he acquired the well-deserved fame of being one of the "most expert chemists in elegant analysis."

In the preliminary legislation that resulted in the establishment of the Smithsonian Institution the practice of chemistry by James Smithson seems to have been borne in mind, for not only in the act to establish the Smithsonian Institution, but also in the subsequent report of the organizing committee "a chemical laboratory" was provided for.

Later, when Professor Henry had been given the direction of the Institution, he refers in his "Program of Organization" to the "chemical analysis of soil and plants" as a means by which "to increase knowledge," and in his first report distinctly avows his appreciation of the value of chemistry in the

following words: "Agriculture would have forever remained an empirical art had it not been for the light shed upon it by the atomic theory of chemistry."

The first mention of any chemical activity in the history of the Smithsonian Institution was in 1848, when an announcement was made of an arrangement (among others) for "a report on the present state of chemistry as applied to agriculture." A year later "a report on the application of chemistry to agriculture," prepared by Lewis C. Beck, of Rutgers College, is announced as "nearly ready for the press," but it does not appear to have been published, and it is probable that the matter was given to the public in 1850 in a course of lectures on the "Chemical Operations of Nature," delivered by Professor Beck in the Smithsonian hall.

The failure to publish this report may be accounted for by the statement so often made by Henry that "it is the policy of the Smithsonian Institution, in order to employ its funds most effectually in the way of increasing and diffusing knowledge, not to engage in any operation which could be as well, if not better, carried on under the direction, and with the funds of another institution," and as an appropriation was made by Congress in 1848 to the Commissioner of Patents for the purpose of investigating the relations of chemistry to agriculture, it is more than likely that Henry deemed it undesirable to encroach on that domain.

The first published contribution to chemistry was the "Memoir on the Explosiveness of Niter," by Robert Hare. It comprised twenty pages and formed the seventh memoir in the second volume of the "Smithsonian Contributions to Knowledge." Its history is interesting. A fire occurred in New York City on July 19, 1845, during which two hundred and thirty houses were destroyed, containing merchandise valued at over two millions of dollars. A peculiar feature of

this catastrophe was a series of detonations successively increasing in loudness, and followed by a final explosion which tore in pieces the building where it occurred, threw down several houses in the vicinity and forced in the fronts of the houses on the opposite side of the street. These effects were attributed to gunpowder, but the owner of the building declared that he had none of that explosive, although a large quantity of niter was stored in the house. Doctor Hare showed by numerous experiments that explosions of a violent character could be produced by forcibly bringing in contact at a high temperature niter and substances of an inflammable character. This memoir was referred to John Torrey and Colonel John J. Abert, and on their recommendation accepted for publication by the Smithsonian Institution in October, 1849. It was published in 1850.

It is interesting to mention that on the title-page of Doctor Hare's memoir he refers to himself as an "associate of the Smithsonian Institution." Among the six honorary members created by the Establishment the names of Robert Hare and Benjamin Silliman — both among the foremost chemists of their time — are conspicuous; they were elected in 1849, and continued in that relation until their death.

The publication of periodic reports summarizing all the discoveries of science and giving a well-digested account of important additions to knowledge was an idea that Henry derived from Berzelius, a Swedish chemist of high reputation. A practical expression of the value of this scheme was demonstrated in 1851 by the publication of a report "On Recent Improvements in the Chemical Arts," compiled by James C. Booth, Assayer of the United States Mint in Philadelphia, and his associate, Campbell Morfit. It consisted of a digest of articles that had appeared during the ten years previous in the various journals of science and the arts in the English,

French, and German languages. The great value of this work is beyond dispute and its appreciation evidenced by the fact that the first edition was soon exhausted and a second one was issued. This is worthy of special note when it is remembered that chemistry was at that time just beginning to receive recognition among colleges in the United States.

The diffusion of knowledge by means of public lectures, especially during the sessions of Congress, had become part of the recognized policy of the Institution, and during the winter of 1852 the younger Silliman delivered a course of six lectures on the four ancient elements: "Earth, Air, Fire, and Water." In the Report for 1853 the announcement was made that J. Lawrence Smith had been engaged to give a full course of lectures on chemistry; and, accordingly, during the winter of 1853–'54 a series of twenty-five lectures was given by Professor Smith. The general character of the course may be inferred from the title of the first. It was: "The improvement of the study of chemistry and its close connection with the progress of the arts and manufactures of the present age; also general notice of the nature of bodies, more especially gaseous bodies."

Although the establishment of a chemical laboratory was provided for in the law incorporating the Institution, it does not appear to have come into existence until its organization by Professor Smith. In the Report for 1854 Henry says: "The laboratory of the Institution during the past year has been used by Professor J. Lawrence Smith in the examination of American minerals; and on behalf of the Treasury Department in investigations relative to the different kinds of molasses imported into this country. He also made a series of analyses of meteorites, among which were fourteen specimens belonging to the cabinet of James Smithson, the founder of the Institution."

It was about this time that Smith was finishing his elaborate memoir on the "Reëxamination of American Minerals," which, according to the younger Silliman, was "the most important contribution yet made by any American chemist." It is not improbable, therefore, that the work begun while he was in the University of Virginia was completed at the Smithsonian Institution.

A year later it appears that a commodious room had been fitted up with the necessary appliances for original research in chemistry and other physical sciences; still no regular chemist was employed by the Institution, although Doctor John D. Easter, who had studied chemistry for three years in Germany, was allowed the use of the laboratory. For the facilities afforded him he was required to keep the apparatus in working order and to make such examinations of specimens as would not require much labor. In the domain of chemistry investigations were conducted on the application of some newly-discovered substances to practical purposes in the arts, and numerous examinations were made of minerals obtained from the Pacific railroad and other expeditions.

During the winter of 1855–'56 George J. Chace, of Brown University, delivered a course of six lectures on "Chemistry Applied to the Arts." No lectures on subjects pertaining to chemistry were delivered for the next two winters, but during 1858–'59 Thomas Clemson lectured on "Water" and on "Nitrogen," and during the same season Josiah P. Cooke, of Harvard College, delivered lectures on "Atmospheric Air," "Oxygen and Zinc," "Nitrogen," "Water," "Carbon," etc. These were followed, during 1859–'60, by a course of six lectures on "Agricultural Chemistry," by Samuel W. Johnson, of Yale College, and later by five lectures treating of the relation of chemistry to geology, by T. Sterry Hunt, then of the Geological Survey of Canada.

Meanwhile the "Smithsonian Contributions to Knowledge" had been enriched by the publication of the results of a most important series of "Researches on the Ammonia-Cobalt Bases," conducted by Wolcott Gibbs and Frederick A. Genth. Henry describes it as "a laborious series of investigations relative to a very interesting part of chemistry." It still continues to rank high as a model investigation, and Doctor Gibbs, now the foremost of American chemists, honored at home and abroad, continues, in the honorable leisure of his well-spent life, to devote part of his time, in his private laboratory in Newport, Rhode Island, to the development of certain portions of this classic research. This memoir was referred to John F. Frazer and John Torrey, and, on their recommendation, accepted for publication in July, 1856, and issued in separate form in December of that year. It is the fifth article in the ninth volume of the "Contributions."

In returning to a consideration of the chemical laboratory, it is desirable to recall those significant words of Henry, already quoted in this article — that it was not the policy of the Smithsonian Institution "to engage in any operation which could be as well, if not better, carried on under the direction and with the funds of another institution." For this reason, perhaps, more than any other the chemical laboratory has never been continuously occupied. During 1857 it was used by Eugene W. Hilgard, who conducted a series of experiments relative to the vapor from a modification of carbon disulphide as a substitute for steam applied to mechanical purposes. His results were unfavorable to the substitution. Also a series of investigations relating to the prevention of counterfeiting bank-notes was carried on. Soon after Professor Hilgard accepted the appointment of State Geologist of Mississippi, and George C. Schaeffer and Doctor Benjamin F. Craig occupied the laboratory. During 1858 they

investigated a large number of specimens of guano. Professor Schaeffer soon withdrew and accepted the more congenial post of librarian of the United States Patent Office, where he remained until his death, always honored and esteemed as a man of varied and exact learning. During the first decade of the second series of the "American Journal of Science," he prepared the chemical abstracts that appeared over the initials of "G. C. S." Doctor Craig remained in charge of the Smithsonian Laboratory, and continued to report on various minerals sent to the Institution, also making such private investigations as came to him from persons desiring the services of a chemist. During 1862 a large quantity of disinfecting fluid was made for the use of hospitals, and during 1863 experiments on the properties of different kinds of oil intended for lighthouse purposes were carried on. In 1864 Doctor Charles M. Wetherill, already well known as the author of "The Manufacture of Vinegar, its Theory and Practice, with Special Reference to the Quick Process" (1860), was given charge of the laboratory, and he continued the examination of materials for lighthouse illumination. Also during 1864 Doctor Wetherill studied the condition of the air and the mode of ventilating the United States Capitol. On this subject he submitted a very elaborate report to the Secretary of the Interior. In the laboratory he was occupied in investigations on the nature of the so-called ammonium amalgam, the crystallization of sulphur, and the crystalline nature of glass.

Chemistry and physics are allied sciences and the appliances used in one science are frequently employed in the other. Elsewhere mention is made of the early gift of physical apparatus to the Institution by Doctor Robert Hare, much of which was of interest on account of its association with the history of the advancement of science in this coun-

try, notably those pieces which had been used by Doctor Hare in his isolation of calcium without the aid of galvanism. To this collection were added in 1859, by the gift of J. R. Priestley (a grandson of the discoverer of oxygen), a burning lens and a condensing air-pump. It was with these instruments that Joseph Priestley discovered the gas which is now called oxygen. With this discovery, made on August 1, 1774, begins the history of modern chemistry.

From the greatest of the early American chemists we return to the first of living American chemists for the purpose of mentioning the grant, in 1859, of a small appropriation to Wolcott Gibbs in order to defray the expenses of the necessary material and apparatus for an investigation relative to the ores of platinum, in which Doctor Gibbs successfully separated the different platinum metals and discovered a series of compounds containing osmium, ruthenium, and iridium. The results of this investigation were permitted by the Smithsonian Institution to appear in the "American Journal of Science," and four papers bearing the general title of "Researches on the Platinum Metals" were published through that medium in the years 1861, 1862, and 1864.

During the winter of 1862–'63, Eben N. Horsford, of the Lawrence Scientific School of Harvard University, delivered a course of five lectures on "Munitions of War," and during the same season Doctor Henry Wurtz, of New York, gave a series of four lectures on "Gunpowder." Thereafter no lectures on chemistry were delivered before the Smithsonian Institution, and subsequent to 1865, owing to a fire that occurred in the building on January 24 of that year, public lecture courses were entirely abandoned.

The appendix to the Report for 1856 contains a paper "On Tables of the Constants of Nature and Art," by Charles Babbage, in which it is said that these constants should include

(among other things): "The atomic weights of bodies, the proportions of the elements of various compounds; acids with bases; metals with oxygen, etc. A list of metals, with columns containing specific gravity, elasticity, tenacity, specific heat, conductive power of heat, conductive power of electricity, melting point, refraction power, proportion of rays reflected out of 1000 at an incident of 90°. List of specific gravities of all bodies." Frank W. Clarke, then of Boston, had for his own purpose compiled certain information of the above character, and in 1873 submitted to the Smithsonian Institution his results, consisting of a table, exclusive of its supplement, which, in his own words, "contains the specific gravities of 2263 substances and over 5000 determinations in all. There are over 2000 determinations of boiling point, representing 1205 different substances, and nearly 500 of melting point for 326 substances. In all, the names of 2572 distinct bodies will be found in this table." This work, entitled "The Constants of Nature. Part I. Specific Gravities; Boiling and Melting Points and Chemical Formula," was submitted for critical examination to Charles A. Joy, and Charles F. Chandler, of Columbia College; and on their recommendation published in December, 1873. It consisted of 263 octavo pages, and was numbered 255 of the "Smithsonian Miscellaneous Collections."

In April, 1876, the Smithsonian Institution issued the "First Supplement to Part I" of "The Constants of Nature" as an octavo pamphlet of sixty-one pages, which contained, "in addition to determinations published during the past two years, some materials which were overlooked in compiling the original work." At the same time there were issued Part II of "The Constants of Nature," consisting of "A Table of Specific Heats for Solids and Liquids" (58 pages), and also Part III, "Tables of Expansion by Heat

for Solids and Liquids" (57 pages), both prepared by Professor Clarke. They are all contained in Volume XIV of the "Smithsonian Miscellaneous Collections."

The chemical laboratory, concerning which mention has already been made, was occupied during 1873–'76 by Doctor Oscar Loew, the chemist and mineralogist of the Geographical Survey under Lieutenant George M. Wheeler. Besides his work for the Survey, he made analyses of minerals, mineral waters, and other substances that were referred to the Smithsonian Institution for examination. He was succeeded by Doctor Frederic M. Endlich, the mineralogist of the Institution, who in turn gave way to Frederick W. Taylor. The latter took charge of the laboratory in the autumn of 1877, and continued in charge until June, 1884. During his administration many improvements were introduced, especially in 1881, when the entire second floor of the southwest pavilion of the Museum building was assigned to Mr. Taylor for a chemical laboratory, which was then equipped with much new apparatus. The work continued to consist chiefly of the identification of minerals, both for the collections and for persons who sent specimens to the Institution for examination. Still, from time to time questions involving chemical research from other departments of the government came to the laboratory for decision. Among those worthy of mention was the controversy between the Custom House authorities in New York and the importers of Apollinaris water, as to whether the article imported under that name really came uncharged from the springs, or was artificially charged with other substances, especially carbon dioxide. A report on this matter was prepared at the request of the Secretary of the Treasury. During this period the Institution was frequently called upon to act as advisor to the departments in securing specialists for investigations too extensive for the

time and apparatus of its chemist, or which for other reasons could not be undertaken by him.

With the resignation of Mr. Taylor the place of official chemist to the Institution ceased to exist. An arrangement was then made between the Secretary of the Institution and the Director of the United States Geological Survey, by means of which the laboratory in the Institution was placed in charge of Professor Clarke, chief chemist of the Survey, with the understanding that Professor Clarke should perform such chemical work as might be called for by the Institution. This procedure was in accordance with the policy of relinquishing such lines of work as could be satisfactorily carried on by other departments of the government, and of fostering only such branches of investigation as were not provided for elsewhere. For nine years nearly all of the chemical work of the Survey was done in the rooms assigned to that work in the Museum building, but in 1892 the analytical work was transferred to the new offices of the Survey. In addition to the foregoing, considerable chemical work pertaining to metallurgy and economic geology was performed during these years in the departments of metallurgy and economic geology and of lithology and physical geology by their respective curators, Frederic P. Dewey and George P. Merrill. Since 1892 such chemical work as has been required by the Institution has been conducted in the laboratory now in the Department of Geology under the direction of the curator, Doctor George P. Merrill.

Soon after the publication of the three parts of the "Constants of Nature," Professor Clarke began collecting data relative to the determinations of atomic weights for the purpose of preparing a complete digest of the entire subject, and of recalculating all the estimations. Much material had been collected and partly discussed when a manuscript entitled

"Atomic Weight Determinations: A Digest of the Investigations Published since 1814," by George F. Becker, was received by the Smithsonian Institution. According to Professor Clarke, to whom it was submitted, "it brought together all the evidence, presenting it clearly and thoroughly in compact form." It was accordingly issued as Part IV of the "Constants of Nature," in August, 1880, forming a pamphlet of 149 pages in the octavo series. Two years later Part V of the "Constants of Nature," consisting of "A Recalculation of the Atomic Weights," by Professor Clarke, was published. It discussed all existing data on the subject, and gave the most probable value to each of the elements. Its publication gained for Professor Clarke the reputation of being a high authority in computing the atomic weights of the chemical elements, and his values are now quoted in most chemical text-books. His results were included in 271 octavo pages, and, together with Mr. Becker's paper, formed the greater part of Volume XXVII of the "Miscellaneous Collections."

In 1881 Secretary Baird began, in the Report, the publication of a series of records of "Scientific Progress." That on "Chemistry," published in 1881, was by George F. Barker; those for 1882–'83–'84–'85 and '86 were by H. Carrington Bolton, and that for 1887–'88 by Professor Clarke. Subsequent to 1888 the series was discontinued, because it was found "impracticable to obtain all the desired reports in each department within the time prescribed."

Mention has already been made of the gift of certain scientific apparatus of a historical character to the Smithsonian Institution, and in 1883 application was made by Baird to Mrs. Priestley, of Northumberland, Pa., for the collection of apparatus used by her husband's ancestor, Joseph Priestley, which had been exhibited at the celebration of the centennial of oxygen in August, 1874. It is gratifying to say that the

collection was subsequently presented by Mrs. Priestley to the Institution for the Museum.

In 1884 the Committee on the Indexing of Chemical Literature of the American Association for the Advancement of Science announced that the Smithsonian Institution had consented to publish indexes to chemical literature that had been indorsed by the Committee. In accordance with this agreement, the Smithsonian Institution has published "Index to the Literature of Uranium, 1789–1885," by H. Carrington Bolton (octavo, 32 pages); "Index to the Literature of the Spectroscope, from the Beginning of our Knowledge of the Subject until July, 1887," by Alfred Tuckerman (423 pages); "Index to the Literature of Columbium, 1801–1887," by Frank W. Traphagen (27 pages); "Index to the Literature of Thermodynamics," down to the middle of the year 1889, by Alfred Tuckerman (239 pages); "Bibliography of the Chemical Influences of Light," 1891 (22 pages); "Bibliography of Aceto-Acetic Ester," 1840–1892, by Paul H. Seymour (148 pages); "Index of the Literature of Didymium" (1842–1893), by A. C. Langmuir (20 pages), and "Indexes to the Literature of Cerium and Lanthanum," 1751–1894, by W. H. Magee (43 pages).

Much new material pertaining to density of various substances had accumulated since Professor Clarke submitted his original compilation of the "Constants of Nature" to the Smithsonian Institution. Therefore, in 1888 he presented a new edition (revised and enlarged) of Part I, "A Table of Specific Gravity for Solids and Liquids," that contained "the specific gravities of 5227 distinct substances and 14,465 separate determinations." This table contained 409 pages, and formed about one-half of Volume XXXII of the "Smithsonian Miscellaneous Collections."

The announcement of the Hodgkins Fund prizes in 1893

was not without value to chemistry. It created at once an interest in the study of the air, and from every part of the world papers were sent to the Smithsonian Institution in competition for the prizes. Of the 218 papers submitted to the jury for consideration, that by Lord Rayleigh and Professor William Ramsay, descriptive of their magnificent discovery of a hitherto unknown element in the atmosphere, received the first prize of $10,000. Under the title of "Argon, a New Constituent of the Atmosphere," the original memoir, as submitted by the authors, was published in May, 1896. It forms one of the papers contained in Volume XXIX of the "Smithsonian Contributions to Knowledge." In it are found the reasons that led the authors to suspect the existence of a new element, and the steps in the investigation that developed the suspicion into belief and conviction, culminating in the absolute proof by several methods, of the presence of a hitherto unknown gas in the atmosphere, which, owing to its chemical inactivity, was called argon.

The third prize, of $1,000, was awarded to Doctor Henri de Varigny for his popular treatise entitled "L'Air et la Vie," which, under the title of "Air and Life," has been published by the Smithsonian Institution. It is an admirable summary of our knowledge of the atmosphere, chemical and otherwise, written in a pleasant style.

The paper by F. A. R. Russell on "The Atmosphere in Relation to Human Life and Health," which was honorably mentioned and received one of the Hodgkins silver medals, is also of a popular character. Among the papers that received honorable mention is one on "Atmospheric Actinometry and the Actinic Constitution of the Atmosphere," by E. Duclaux, of Paris, France. It was recommended by the award committee for publication, and is included in Volume XXIX of the "Smithsonian Contributions to Knowledge." It is here

mentioned because of its chemical character, for it is essentially a description of a series of experiments that show how a weak solution of oxalic acid is oxydized by the influence of the chemical rays of sunlight, and hence that such a solution can be used as an actinometric measure.

A paper entitled "The Air of Towns," presented by Doctor J. B. Cohen, of Yorkshire, England, likewise received honorable mention. It consists of four popular lectures on "Close Rooms," "Smoke," "Town Fog," and "Germs of the Air"; and these were of such practical character that they were deemed worthy of prompt publication.

In the original circular concerning the Hodgkins Fund prizes it says that "special grants of money may be made to specialists engaged in original investigation upon atmospheric air and its properties." In accordance with this provision a grant of $500 was made to Doctor Otto Lummer and Doctor Ernst Pringsheim of Berlin, Germany, for researches on the determination of an exact measure of the cooling of gases while expanding, with a view to revising the value of that most important constant which is technically termed "gamma" function. This grant was made on recommendation of Professor von Helmholtz. In the same year a second grant, amounting to $1000, was placed at the disposal of Doctor John S. Billings, of Washington City, and of Doctor S. Weir Mitchell, of Philadelphia, Pennsylvania, for an investigation into the nature of the peculiar substances of organic origin contained in the air expired by human beings, with a specific reference to the application of the results obtained to the problem of ventilation for inhabited rooms. The investigation undertaken by these scientists was carried on in the Laboratory of Hygiene in the University of Pennsylvania, largely by Doctor David H. Bergey, and under their joint names the Smithsonian Institution in Novem-

ber, 1895, published their results with the title, "The Composition of Expired Air and its Effects upon Animal Life." They concluded that dust particles are the only really dangerous elements in the air, and that it is improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals other than carbon dioxide. It forms one of the papers contained in Volume XXIX of the "Smithsonian Contributions to Knowledge." In June, 1896, the "Methods for the Determination of Organic Matter in Air" used by Doctor Bergey was published by the Institution, and is contained in Volume XXXIX of the "Smithsonian Miscellaneous Collections." Both of these papers are credited to the Hodgkins Fund.

The year 1893 was conspicuously celebrated throughout the United States as the four hundredth anniversary of the discovery of America. In the annals of chemistry that year stands out prominently as the one in which the Smithsonian Institution honored that science by the publication of H. Carrington Bolton's magnificent "Select Bibliography of Chemistry, 1492–1892." Secretary Langley wrote: "It represents the labor of a lifetime on the part of a most industrious student of the bibliography of chemistry, and is a work of reference of such value that it is believed it will be a necessity to every chemical investigator." It contains 12,000 titles, and forms Volume XXXVI of the "Smithsonian Miscellaneous Collections." The first edition was soon exhausted, and a second one was issued. Dr. Bolton has in hand a supplement, to include similar titles to 1895.

The granting of funds for the purpose of prosecuting original investigations in science is one of the means of increasing knowledge that has been more common in the recent history of the Smithsonian Institution than was formerly the case. The present Secretary has ever shown a kindly feeling to-

ward chemistry, and in his Report for 1891 he announced that a sum of $600 had been placed at the disposal of Edward W. Morley, to procure a special apparatus for determinations of the density of oxygen and hydrogen, which he properly designates as "an investigation requiring extreme precision and delicacy of manipulation, and promising results of wide application." In the same Report mention is made of the grant of $200 to Wolcott Gibbs, to aid in the completion of his investigations of the physiological action of chemical compounds. Doctor Gibbs subsequently published his results in the *American Chemical Journal*.

The last item to be chronicled in this necessarily brief history of the relation of the Smithsonian Institution to chemistry was the purchase of a balance — more delicate than any in the United States — which was loaned to Edward W. Morley for use in his masterly redetermination of certain physical constants of oxygen and hydrogen, concerning which it has been well said that "the classical researches of Regnault are far excelled by the investigations so far made by Morley." The Smithsonian Institution has also published Professor Morley's results "On the Density of Oxygen and Hydrogen and on the Relation of their Atomic Weights," on the recommendation of Frank W. Clarke and Carl Barus. It contains 109 pages, and is included in Volume XXIX of the "Smithsonian Contributions to Knowledge."

No more conspicuous illustrations of the perfect operation of the exact wording of the will of James Smithson could be shown than those just mentioned. Knowledge — and that of the very best kind — has been increased by the promotion of the research conducted by Professor Morley, and knowledge has been diffused by the publication of his results, which constitute, indeed, the finest physico-chemical investigation ever undertaken and completed in this country.

In conclusion, a list of the chemical papers that have appeared in the annual reports is herewith appended:

"Oxygen and its Combinations," by George I. Chace, 1855.

"Memoir of Priestley," by M. Cuvier (translated by C. A. Alexander), 1858.

"Lectures on Agricultural Chemistry," by Samuel W. Johnson, 1859.

"Scientific Congress of Carlsruhe" (Section of Chemistry), by M. J. Nickles (translated by C. A. Alexander), 1860.

"The Sun: Its Chemical Analysis," by Auguste Laugel, 1861.

"Notes on the History of Petroleum or Rock Oil," by T. Sterry Hunt, 1861.

"Report on Nitrification," by Benjamin F. Craig, 1861.

"Explosibility of Coal Oils," by T. Allen, 1861.

"Destructive Effect of Iron Rust" (from the German), 1861.

"Memoir of Louis Jacques Thénard," by M. Flourens (translated by C. A. Alexander), 1862.

"The Catalytic Force; or, Studies on the Phenomena of Contact," by T. J. Phipson (translated by C. A. Alexander), 1862.

"On Atoms," by Sir John Herschel, 1862.

"A Brief Sketch of the Modern Theory of Chemical Types," by Charles M. Wetherill, 1863.

"Purple Dyeing, Ancient and Modern" (from the German), 1863.

"Ozone and Antozone," by Charles M. Wetherill, 1864.

"Vegetation and the Atmosphere," by J. Jamin, 1864.

"Extract of a Memoir on the Preservation of Copper and Iron in Salt Water," by M. Becquerel, 1864.

"Preservation of Wood" (translated from the German by C. A. Alexander), 1864.

"Caoutchouc and Gutta Percha" (translated from the German), 1864.

"The Products of the Combustion of Gun-cotton and Gunpowder under Circumstances Analogous to Those Which Occur in Practice," by Lieutenant von Karolyi, 1864.

"Description of Apparatus for Testing Results of Perspiration and Respiration in the Physiological Institute at Munich," by Max Pettenkofer (translated by A. Ten Brook), 1864.

"Photochemistry," by M. Jamin (translated from the French), 1867.

"Notice of Christian Frederic Schœnbein, the Discoverer of Ozone" (translated from the "Archives des Sciences Physiques et Naturelles, Geneva"), 1868.

"Appendix to Notice of Schœnbein," by Joseph Henry, 1868.

"A Brief Account of the Processes Employed in the Assay of Gold and Silver Coins at the Mint of the United States" (from the Annual Report of James Pollock), 1868.

"On the Chemistry of the Earth," by T. Sterry Hunt, 1869.

"Hydrogen as a Gas and as a Metal," by Doctor J. Emerson Reynolds, 1870.

"On Professor Thomas Graham's Scientific Work," by William Odling, 1871.

"Organic Bases," by Professor A. Bauer (translated from the German), 1872.

"The Nitrogen Bodies of Modern Chemistry," by Professor Kletzinsky (translated from the German), 1872.

"Scheme for the Qualitative Determination of Substances by the Blowpipe," by Thomas Egleston, 1872.

"Eulogy on Gay-Lussac," by M. Arago, 1876.

"Chemistry," by George F. Barker, 1880.

"Chemistry," by George F. Barker, 1881.

"Chemistry," by H. Carrington Bolton, 1882.

"Chemistry," by H. Carrington Bolton, 1883.

"Chemistry," by H. Carrington Bolton, 1884.

"Chemistry," by H. Carrington Bolton, 1885.

"Index to the Literature of Uranium," by H. Carrington Bolton, 1885.

"Chemistry in 1886, with Bibliography," by H. Carrington Bolton, 1887.

"Chemistry for 1887 and 1888," by F. W. Clarke, 1888.

"The Life-work of a Chemist" [Pasteur], by Sir Henry E. Roscoe, 1889.

"Aluminum," by Horace C. Hovey, 1889.

"Alloys of Aluminum," by J. H. Dagger, 1889.

"The Chemical Problems of To-day," by Victor Meyer, 1890.

"Autobiographical Sketch of Justus von Liebig" (translated from the German by J. Campbell Brown), 1891.

"Deduction from the Gaseous Theory of Solution," by Orme Masson, 1892.

"Some Suggestions Regarding Solutions," by Professor William Ramsay, 1892.

"Liquids and Gases," by Professor William Ramsay, 1892.

"Atoms and Sunbeams," by Sir Robert Ball, 1893.

"Magnetic Properties of Liquid Oxygen," by Professor James Dewar, 1893.

"On Chemical Energy," by Doctor W. Ostwald, 1893.

"The American Chemist," by George C. Caldwell, 1893.

"The Waste and Conservation of Plant Food," by Harvey W. Wiley, 1894.

"The Relations of Physiology to Chemistry and Morphology," by Giulio Fano, 1894.

"The Place of Research in Education," by Henry E. Armstrong, 1895.

"Eulogy on Pasteur," by George M. Sternberg, 1896.

GEOLOGY AND MINERALOGY

By William North Rice

Professor of Geology, Wesleyan University

THE aim of the Smithsonian Institution, as defined in the will of its illustrious founder, is twofold — "The increase and diffusion of knowledge." While its contributions in the department of geology have been less extensive than in some other departments of science, they have been by no means unimportant. The Institution has rendered valuable service in both the *increase* and the *diffusion* of the knowledge of the constitution and history of the globe on which we live.

I. PUBLICATIONS

Attention turns naturally first to the publications of the Institution. These include both original papers and reprints of papers published elsewhere. The original papers on geology and mineralogy may be conveniently classified for present purposes in three divisions: 1. Miscellaneous papers; 2. Papers immediately relating to the collections in the National Museum or displayed in the temporary expositions in which the Institution has been represented; 3. Reports of the progress of particular branches of science.

MISCELLANEOUS PAPERS

AMONG the somewhat elaborate publications included in the quarto series ("Smithsonian Contributions to Knowledge"), several have been of sufficient importance to the progress of geology to deserve special notice.

J. W. Bailey's paper, entitled "Microscopical Examinations of Soundings, made by the United States Coast Survey off the Atlantic Coast of the United States" (1851) is an interesting piece of pioneer work in a field destined to be earnestly cultivated, and to yield a rich harvest in the succeeding half-century. The observation that, as the soundings increased in depth (though none of them much exceeded 100 fathoms), the quartzose and feldspathic constituents of the seashore sands gave place gradually to the calcareous remains of foraminifera, was a discovery of prophetic interest.

Two important papers relate to surface geology, or the geology of the Quaternary era. "Illustrations of Surface Geology," by Edward Hitchcock (1857), is a valuable investigation in a department of geology which had then received but little attention. The maps and sections of terraces of the Connecticut River and its tributaries give evidence of most thorough and conscientious work. The progress of science in the past forty years has, indeed, very largely changed the interpretation of the facts so faithfully observed and recorded. The increased knowledge of the dynamics of glaciers has answered the objections which compelled President Hitchcock to attribute the Drift to the action of ice-floes. The marks of the action of glaciers, which he was sagacious enough to recognize in various localities in Massachusetts and Vermont, can now take their place as illustrations of particular phases of the action of the same agency which produced the Drift, instead of being arbitrarily distinguished.

The dynamics of river action, also, we understand better than forty years ago. Few, if any, geologists to-day would attribute the formation of valleys to the ocean; and most geologists doubtless would approve Gilbert's elegant transformation [1] of Hitchcock's diagram exhibiting the structure of terraces. But the paper is an interesting monument of the early stages of the history of glacial geology, and much more of the same sort of conscientious study of the facts in detail will be requisite before all the problems of the Drift are satisfactorily solved.

The paper "On the Fresh-water Glacial Drift of the Northwestern States," by Charles Whittlesey (1866), maps approximately the southern boundary of the Drift from New Jersey to Iowa (locating the boundary most of the way somewhat further north than more recent authorities). Attention is called to the moraines far to the north of the boundary of the Drift, and their characteristic surface pitted with kettle-holes. Numerous small lakes and bays are attributed to glacial erosion, and the basins of the great lakes are believed to have been somewhat modified by the same agency. The unstratified Drift is referred to the action of glaciers, and the stratified deposits to fresh waters.

Colonel Whittlesey contributes also one paper in the department of physiography, "On Fluctuations of Level in the North American Lakes" (1860). This paper gives a large amount of information bearing upon secular, annual, and transient variations. Very curious are those transient oscillations, which have been studied and described by a number of observers in the Swiss Lakes, under the name of "seiches," and of which Colonel Whittlesey's paper is probably the first notice in this country. They are doubtless connected with variations of atmospheric pressure. Although, in some cases

[1] "Report on Geology of the Henry Mountains," Washington, 1877, Figures 64, 65.

reported, there was no barometric fluctuation at the point of observation at the time when the seiche was observed, the explanation is doubtless, as suggested in a note by Professor Henry, to be found in the occurrence of thunder-storms in distant parts of the lake.

"Geological Researches in China, Mongolia, and Japan during the years 1862 to 1865," by Raphael Pumpelly (1866), is an important contribution to the knowledge of a field then almost untrodden by geological explorers, though destined soon after to be illustrated by the more extended travels and researches of Baron von Richthofen. The loess of northern China is in this paper considered a lacustrine deposit, though the author afterward adopted Richthofen's view of its æolian origin. The wonderful migrations of the Hoang Ho River over the immense confluent delta which it shares with the Yang-tse-Kiang is illustrated by a most interesting series of maps. Much information is given in regard to the coal of Chihli and adjacent provinces of northern China, which is considered Mesozoic, on the evidence of ferns, cycads, and a conifer described by Professor Newberry. The coal of Chihli was pronounced Jurassic by Richthofen, though in other parts of China coal of Carboniferous age is extensively developed.

The paper "On the Geology of Lower Louisiana and the Salt Deposit on Petite Anse Island," by Eugene W. Hilgard (1872), discusses a deposit whose scientific interest even exceeds that which arises from its economic value. The salt, which is overlain by the Orange Sand, is held to be of Cretaceous age.

The subject of the physics of the globe is treated in two papers by J. G. Barnard, the first on "Problems of Rotary Motion" (1872), the second "On the Internal Structure of the Earth" (1877). In both papers the question is discussed

mathematically, whether the phenomena of precession afford conclusive evidence as to the constitution of the interior of the earth. In the former paper, General Barnard holds that the phenomena of precession require a solid globe. In the latter paper, he holds that the precession of a liquid would be substantially the same as that of a solid globe, having become convinced, like Lord Kelvin, of the validity of Professor Simon Newcomb's criticism.

Numerous short papers bearing upon geology and mineralogy occur in the annual Reports of the Smithsonian Institution and in the "Bulletins" and "Proceedings" of the National Museum. Detailed comment on these papers is precluded by the limits of this article, though many of them have an importance disproportionate to their length. A few of them are briefly mentioned.

Joseph Le Conte's "Lectures on Coal" (Report, 1857) are a model of truly popular exposition of a scientific theme. The treatment of the paleontological part of the subject belongs, of course, to the pre-Darwinian epoch, then near its end.

T. S. Hunt's report "On the Chemistry of the Earth" (Report, 1869) is a very compact summary of the views on chemical geology, which are more fully presented in his "Chemical and Geological Essays," and other writings.

W. N. Rice gives results of studies on "The Geology of Bermuda" (Bulletin, No. 25). He holds the islands to be an atoll, originally formed by subsidence, in accordance with the views of Darwin and Dana; but supposes the subsidence to have been interrupted by an epoch of elevation in which enormous accumulations of æolian limestone were formed.

T. Egleston's "Catalogue of Minerals and Synonyms" (Bulletin, No. 33) is an exceedingly handy little volume for reference. All mineralogical names are given in alphabetical order; while names of recognized species are distin-

guished by being printed in capitals, and are followed by statements of chemical composition and crystalline form, and by lists of synonyms and varieties.

G. W. Hawes (Proceedings, Volume IV) shows that the Triassic diabases of the eastern United States contain not only labradorite, but various other feldspars, among which are andesine, anorthite, and albite. He also calls attention to the frequent absence of twinning structure in the triclinic feldspars, and the consequent unreliability of optical determinations not checked by chemical analysis.

G. P. Merrill has published numerous papers on mineralogical and lithological subjects in the "Proceedings of the National Museum." Among them is one somewhat elaborate paper entitled, "Notes on Some Eruptive Rocks from Gallatin, Jefferson, and Madison Counties, Montana" (Volume XVII). In several notes on "Serpentines," from various localities (Volumes XI, XII), evidence is given of the derivation of serpentine from olivine and other anhydrous magnesian silicates. The glistening surfaces, like slickensides, in the serpentines, are attributed to the friction of movements due to the expansion of the mass in undergoing hydration. Interesting studies on points of detail in geological structure are given in notes "On Fulgurites" (Volume IX), "On Stalactites and Gypsum Incrustations," and on "Sandstone Concretions" (Volume XVII). A note "On Deposits of Volcanic Dust and Sand in Southwestern Nebraska" (Volume VIII) records the first known observation of unaltered volcanic ashes or tufa in the United States east of the Rocky Mountains.

C. T. Simpson discusses (Volume XVI) the Unios found in the deposits near Toronto supposed to be interglacial. All are species belonging to the fauna of the Mississippi Valley, and most of them are no longer found in Canada. Their introduction into the drainage basin of the St. Lawrence dates

from the time when the St. Lawrence valley was filled with ice, and the great lakes at the southern margin of the ice sheet drained southward into the Mississippi.

PAPERS RELATING TO THE COLLECTIONS IN THE NATIONAL MUSEUM

AMONG the interesting papers relating to the Museum should be mentioned the "Catalogue of Meteorites," by F. W. Clarke, and the description of "The Gem Collection," by G. F. Kunz (Report, 1886). G. P. Merrill's paper on "The Collection of Building and Ornamental Stones" (Report, 1886) is much more than a catalogue, being an exceedingly valuable monograph, treating the stones in both geological and economical relations. The same author has given, in his "Preliminary Handbook for the Department of Geology" (Report, 1889), and "Handbook for the Department of Geology, Part I" (Report, 1890), not only admirable descriptions of the collections, but also valuable treatises on dynamical geology and lithology. Another such paper, far transcending the character of a simple catalogue, and ranking as an important treatise, is F. P. Dewey's "Preliminary Description of Catalogue of the Systematic Collections in Economic Geology and Metallurgy" (Bulletin, No. 42).

REPORTS OF PROGRESS

As these papers are themselves abstracts of a mass of literature, any attempt to give abstracts of them would be useless. Nor is it necessary to comment on the utility of such summaries of scientific work. The names of the authors are sufficient guarantee of the quality of the work. These papers are contained in the Reports for the years 1880 to 1888.

The authors of the various accounts of progress were well known men of science, as follows:

Geology, G. W. Hawes, T. S. Hunt, N. H. Darton, W J McGee; Mineralogy, G. W. Hawes, E. S. Dana; Petrography, G. P. Merrill; Vulcanology and Seismology, C. G. Rockwood, Jr.

REPRINTS

An appropriate memorial of the honored founder of the Institution is afforded by the republication of "The Scientific Writings of James Smithson," extracted from the "Philosophical Transactions of the Royal Society of London," and from "Thomson's Annals of Philosophy." Most of these papers are now chiefly interesting as illustrating the character of one of the benefactors of humanity. The paper entitled "A Chemical Analysis of Some Calamines" (1802) gives the proof that one of the minerals formerly confounded under the name calamine is a carbonate of zinc, while the other affords on analysis silica and oxide of zinc. The former is now most appropriately named smithsonite. The ingenious refutation of Granville Penn's theory that the fossils found in Kirkdale Cave were relics of the Noachian deluge gives an interesting illustration of the state of geological opinion at the close of the first quarter of this century.

The scientific papers to which from time to time a wider circulation has been given by their republication in the Smithsonian Reports, have been sometimes selected as giving accounts of new and important discoveries, sometimes as dealing with broad generalizations and correlations.

A. Geikie's brilliant address on "Geological Change, and Time" (1892) affords an admirably clear and comprehensive view of the spirit and method of geological study.

The important but difficult problems of the physics of the

globe are treated in papers by A. Blytt, H. Hennessy, C. Chree, and G. K. Gilbert.

C. D. Walcott, in a paper entitled "Geologic Time, as Indicated by the Sedimentary Rocks of North America" (1893), investigates especially the rate of accumulation of Paleozoic sediments in the Cordilleran Sea. The general conclusion is reached that geologic time "can be measured by tens of millions but not by single millions or hundreds of millions of years." This is in harmony with C. King's paper on "The Age of the Earth," in the same volume, in which the theory of the mode of cooling of the earth is investigated in the light of recent experiments on the latent heat of fusion, specific heat, and expansion in melting of diabase.

A. Daubrée's paper on "Deep-sea Deposits" (1893) gives an admirable summary of the results of the voyage of the *Challenger*, and other recent explorations, on a subject of profound interest to the geologist.

Important contributions to the geology of particular regions are given in T. Thoroddsen's "Volcanic Eruptions and Earthquakes in Iceland within Historic Times" (1885), and in A. Hague's "Geological History of the Yellowstone National Park" (1892).

A. Brezina's "Explanation of the Principles of Crystallography and Crystallophysics" (1872) is a remarkably compact and elegant exposition of Miller's crystallographic system and of the optical characters of crystals. The theory of crystal formation is illustrated by valuable papers by J. W. Judd and C. D. Liveing.

The short paper by E. Orton on the "Origin of the Rock Pressure of Natural Gas in the Trenton Limestone of Ohio and Indiana" (1891) is valuable for the clearness and beauty of its scientific reasoning, and for the economic importance of the subject which it treats.

J. Geikie's "Glacial Geology" (1889) summarizes clearly and comprehensively the recent progress in knowledge of the events of the Quaternary in Europe. A. R. Wallace's "The Ice Age and Its Work" (1893) affords an elegant sketch of the rise of the glacier theory, and an able argument in favor of the formation of lake basins by glacial erosion. G. K. Gilbert's "History of the Niagara River" (1890) is an elegant discussion of one of the most interesting problems of American Quaternary geology.

E. Desor's "Palafittes, or Lacustrian Constructions of the Lake of Neuchatel" (1865) was given to the American public through the medium of the Smithsonian Report, most seasonably, when the evidences of the antiquity of man were beginning to attract the attention of thoughtful men.

II. EXPLORATIONS

A PROMINENT department of activity in all the history of the Institution has been the exploration of regions imperfectly known, especially in North America. In some cases expeditions have been fitted out under the direction of the Institution. In other cases aid and counsel have been given to parties organized by private enterprise or by various departments of the government. These expeditions have resulted in the acquisition of rich stores of knowledge of the geology of the regions traversed; and the National Museum has been enriched with minerals, rocks, and fossils, as well as with specimens illustrative of botany, zoölogy, and anthropology.

One of the earliest of these expeditions was that of Thaddeus Culbertson to the Mauvaises Terres of the Upper Missouri in 1850; and the spoils of this expedition were a part of the material with which Doctor Leidy began the study of the Tertiary mammalian fauna of the West. In the Re-

port for 1851 it is stated "that the specimens are of much scientific interest, showing, as they do, for the first time, the existence in this country of an Eocene deposit rivaling in the number of its species of extinct animals the celebrated basin of Paris." This was the modest prophecy of that wealth of discovery in mammalian paleontology which was destined to be made in the half-century of this history by Leidy, Marsh, Cope, Osborn, and Scott.

Until the organization of the United States Geological Survey, the Smithsonian Institution was the headquarters of the geologists in the service of the government. The Institution aided in providing their outfit, its annual Reports briefly announced their discoveries, and their collections were received into its Museum, and studied within its walls or under its direction. The geological work done by the Mexican Boundary Survey, the Pacific Railroad Surveys, the Colorado expedition of Lieutenant Ives, the expeditions of Lieutenant (afterward General) Warren to the Yellowstone, the Black Hills, and the Loup Fork, the explorations of Doctor D. D. Owen, Foster and Whitney, Doctor Charles T. Jackson, Doctor John Evans, and Doctor F. V. Hayden were all more or less intimately related with the Smithsonian Institution. Within its walls were carried on the patient and conscientious labors of F. B. Meek, by which the paleontology of the United States was so greatly advanced.

The Institution actively coöperated in the expedition to Alaska under the auspices of the Western Union Telegraph Company; and Kennicott and Dall and the other naturalists of that expedition were among the scientific men whose headquarters was in the Institution. Much of geological knowledge was gained by this expedition.

In 1867 geology acquired a more independent position than it had previously held in relation to the government of the

United States. Prior to that date most of the geological work under the auspices of the United States government had been done by expeditions undertaken primarily for some other object. The place of geology had been, as Clarence King has well expressed it, that of a camp-follower. The next few years were marked by the achievements of four great organizations devoted specifically to geological work: the Survey of the Fortieth Parallel, under Clarence King; the Survey West of the One Hundredth Meridian, under Lieutenant Wheeler; the Survey of the Territories, under Doctor Hayden; and the Survey of the Rocky Mountain Region, under Major Powell. All these explorations were aided by the Smithsonian Institution, and helped to enrich its Museum by their collections.

After the organization of the United States Geological Survey in 1879, the geologists in government employ had a headquarters of their own in Washington, and their work was naturally less intimately related to the Smithsonian Institution. Yet the two organizations, entirely independent, have been mutually helpful. Several of the geologists of the Survey have been at the same time curators in the National Museum.

One exploration deserves special mention in this connection, because placed by act of Congress specifically under the direction of the Smithsonian Institution — the exploration of the Colorado River and its tributaries, by Major Powell, in the years 1869–'72. The report was submitted to the Secretary of the Smithsonian Institution, though not published as one of its series of documents. The intrepid and adventurous character of the expedition and the brilliant style of the narrative make the report of this exploration one of the most interesting stories of scientific travel. But the report is of greater importance as containing the formulation of the doc-

trine of base levels, and the definition of antecedent, consequent, and superimposed drainage. These ideas have proved richly fruitful. As they have been developed by Gilbert, Davis, and others, they have marked an epoch in dynamical geology. With, perhaps, the exception of Dana's doctrine of the permanence of continents, these conceptions in regard to drainage have been the most characteristic contribution to geologic science which this country has made. Nowhere else in the world could these ideas have been so well developed as in presence of the gigantic, yet strangely simple, features of the plateau country through which the Colorado and its tributaries have carved their way. The doctrine of base levels is as natural a development of the American cordillera as the notion of plains of marine denudation is of the wave-beaten island of Great Britain.

It is, indeed, probable that the course of the Green River through the Uinta Mountains is not a perfectly uncomplicated example of antecedent drainage. Probably Davis is correct in saying that "the mountains wrenched the saw that afterwards cut them in two."[1] It may even be true, as supposed by Emmons,[2] that the river is superimposed, rather than antecedent. But, however this may be, the formulation of the general principles of drainage in the exploration of the Colorado has been no less truly epoch-making in its influence.

III. THE NATIONAL MUSEUM

THE collections of the National Museum have exerted a potent influence in the advancement and diffusion of knowledge in the geologic as in other scientific fields. The treasures gathered by the various exploring expeditions, and studied under the direction of the Institution by specialists both

[1] *National Geographic Magazine*, Volume II, page 103.
[2] "Report of the Geological Exploration of the Fortieth Parallel," Volume II, page 197.

within and without its walls, have yielded rich results. Reference has already been made to the work of Leidy and Meek, respectively, on the vertebrate and invertebrate fossils from the West.

The exhibition collections, with their systems of arrangement and labeling continually improved by earnest work on the part of the curators, under the inspiration of that genius for museum administration which distinguished the late director, the lamented Doctor Goode, have been widely and beneficently influential for good. Apart from their value as a means of scientific information to the general public, they have been an object-lesson to geological instructors in colleges and schools, and to curators of geological collections in local museums. Thus they have served to increase the educational value of geological collections throughout the country.

Particular attention may well be called to the collection illustrating dynamical geology, interestingly described by Doctor Merrill in his "Preliminary Handbook of the Department of Geology." Collections in mineralogy, lithology, and paleontology are to be found in about all museums. But systematically arranged and well-labeled collections illustrating the subject of dynamical geology have scarcely existed in the past, and are still comparatively few. Yet a good collection of dynamical geology can be made far more intelligible, and therefore far more instructive, to the general public, than collections in any other department of geological science; while its value to the student is inestimable. The example of so instructive a collection of this sort in the National Museum cannot fail to exert a wide influence upon the schools and local museums of the country.

In still another way the National Museum has richly contributed to the diffusion of knowledge in geology and the cognate sciences — namely, by the liberal distribution of

material to the small museums scattered throughout the country. In many a school and in many a community, the collections of minerals and rocks presented by the Smithsonian Institution, authentically labeled so as to serve as a standard, have stimulated the pursuit of the studies which those collections illustrate. Though no data are available for an estimate of the amount of influence which these donations to local museums have exerted, there can be no doubt that it has been very considerable.

IV. LECTURES

In the early years of the Institution, free public lectures on scientific subjects were given in its hall and under its auspices, especially during the sessions of Congress. The Report for 1849 mentioned a course on "Geology," given by Edward Hitchcock, President of Amherst College. In 1851 the elder Silliman, of Yale College, delivered two lectures on "Geology," and a year later he gave a course of twelve lectures on the same subject. During the winter of 1856–'57 Joseph LeConte, then of Georgia, delivered three lectures on "Coal" and also three on "Coral." James D. Dana, of Yale College, lectured on "Coral Islands" during the winter of 1858–'59. During the following winter T. Sterry Hunt, then of the Geological Survey of Canada, delivered five lectures with titles as follows: "On Chemical and Physical Geology"; "Introduction of Geological Agencies"; "Chemistry of the Earth's Crust"; "Life in Its Geological Relations"; "Geology of the Metals, Mineral Springs, Metamorphism"; and "Igneous Rocks, Volcanoes, Mountain Chains." In 1862 Fairman Rogers, of Philadelphia, Pennsylvania, gave three lectures on "Glaciers." This was followed in 1863 by a course of three lectures on "The Glacial Period," by Louis Agassiz, of Harvard

College. Lectures on related subjects were delivered by well-known scientists, including Charles Henry Davis, Henry Darwin Rogers, Stephen Alexander, Daniel Wilson, and Arnold Guyot. The regular delivery of these lectures was interfered with by the progress of the Civil War, and in 1865 by the fire that destroyed the lecture-room, For a time thereafter the Institution subsidized lecture courses in other institutions in the City of Washington. In the early years, when science had scarcely naturalized itself in this country, these lectures in the national capital, and under quasi-authoritative auspices, served a most valuable purpose in stimulating public interest in scientific subjects.

METEOROLOGY

By Marcus Benjamin,

Fellow of the Chemical Society of London

AMERICAN meteorology began with the Reverend John Campanius, a Swedish clergyman who settled near the present site of Wilmington, Delaware, in 1643. Campanius, the "first meteorological observer on the western continent," kept an account of the weather, day by day, during the years 1644–'45.[1]

The systematic gathering of meteorological information was continued by individuals at different places. Among the observers worthy of special mention were: Doctor John Lining, who, from 1738 till 1750, noted the climatic conditions in Charleston, South Carolina, and was the first to make a series of instrumental observations in the United States;[2] John Winthrop, of Harvard College, who in 1742 began to collect such data, and continued the practice for more than twenty years;[3] and John Bartram, the botanist, who made observations in his famous gardens on the Schuylkill in 1748,

[1] Henry, Alfred J., "Early Individual Observers in the United States." See page 293 of Part 2, "Bulletin, No. 11, of the Weather Bureau," being a "Report of the International Meteorological Congress held in Chicago, Illinois, August 21–24, 1893." Washington, 1895.

[2] *Ibidem*, page 295. [3] *Ibidem*, page 296.

and again in 1758–'59 and in 1761–'77. His manuscript is preserved by the American Philosophical Society in Philadelphia.[1] Of conspicuous interest are the series of observations made by Thomas Jefferson in Monticello in 1772–'78, and toward the close of this period he instituted, with James Madison, a series of simultaneous observations in Monticello and at William and Mary College, Williamsburg, Virginia. These, it is believed, were the first simultaneous observations made in this country.[2]

In 1814 the Army Medical Department issued a rule, making it the duty of each hospital surgeon and director of a department "to keep a diary of the weather."[3] The collection of these observations was fostered by Surgeon-General Joseph Lowell, and a systematic gathering of reports of temperature, pressure, and moisture of the air, the amount of rain, direction and force of wind, appearance of the sky, and other phenomena ensued, resulting in the publication of three volumes of "Meteorological Registers," the last of which, issued in 1851, covered the period from 1831 to 1842. The active operations of this service continued until the beginning of the Civil War.

Contemporary with the foregoing was the collection of meteorological data begun in 1817 by Josiah Meigs, then Commissioner of the General Land Office. He issued blank forms of a meteorological register to the officials of the various local land offices scattered through the States. This service became, in time, the parent of the observations made under the direction of the Patent Office, and continued until 1859.[4]

1 Henry, Alfred J., "Early Individual Observers in the United States." Page 297.

2 Harrington, Mark W., "History of the Weather Map," page 327, "Bulletin No. 11, of the Weather Bureau." Washington, 1895.

3 Smart, Charles, "The Connection of the Army Medical Department with the Department of Meteorology in the United States." Page 208, "Bulletin No. 11 of the Weather Bureau." Washington, 1895.

4 Goode, G. Brown, "The Origin of the National Scientific and Educational Institutions of the United States." Report of the American Historical Society, 1889, page 138.

During the decade in which the Smithsonian Institution came into formal existence three distinguished American meteorologists — perhaps the three most distinguished that this country has ever known — were actively studying the phenomena of storms. These men were Redfield, Espy, and Loomis. It was Redfield who advanced the circular theory of storms, and it was Espy who accounted for their existence by convectional indrafts, while the patient Loomis gathered the essential truths from both and formulated them in his "Contributions to Meteorology," which he later gave to the world through the medium of the "American Journal of Science." Redfield was occupied with many interests, and Loomis was professor of mathematics in the University of the City of New York. Espy, on the other hand, was a professional meteorologist, and of the three he concerns us the most.

The publication of his papers had gained for Espy a high reputation, extending across the ocean, and in 1840 he was invited to explain his theory of storms before the British Association. From England he crossed to the Continent, and in Paris he spoke so acceptably before the French Academy of Sciences that the great Arago exclaimed: "England has its Newton, France its Cuvier, and America its Espy." [1]

On his return to the United States he settled in Washington, and from 1840 till within a few years of his death he was continuously engaged by the government in meteorological work.[2] In 1841 he published his "Philosophy of Storms," and he was familiarly known as the "Storm King." Accord-

[1] "A Few Incidents in the Life of Professor James P. Espy," by his niece, Mrs. L. M. Morehead. Cincinnati, 1888. Page 17.

[2] "The records of the War Department show that James P. Espy was appointed clerk August 26, 1842, and resigned June 30, 1847." He was employed to perform meteorological work, and was appointed by the Secretary of War under act of Congress, August 23, 1842. The records of the Navy Department show that he was appointed Professor of Mathematics in the United States Navy on May 7, 1842, which place he held until July 5, 1845. He also served the Navy Department as Meteorologist from August 10, 1848, until the close of the year 1857.

42

ing to the memoirs of John Quincy Adams, a letter from Espy was received in 1842 by the Committee on the Smithsonian Bequest, in which he proposed that "a portion of the fund should be appropriated for simultaneous meteorological observations all over the Union, with him for central national meteorologist, stationed at Washington, with a comfortable salary."[1]

In December, 1846, Henry was elected Secretary of the Smithsonian Institution, and, already familiar with the meteorological work done at the Albany Academy[2] during his administration there, he was quick to urge in his "programme of organization" "a system of extended meteorological observations for solving the problem of American storms."

In a letter to Jared Eliot, dated Philadelphia, July 16, 1747, Franklin, our first great scientist, expressed the opinion, not original with him, however,[3] that "the course of the storm is from southwest to northeast." The work of subsequent meteorologists had all tended to show that storms did progress in accordance with definite laws, and that most storms began in the west and traveled toward the east. Henry was not satisfied with simply urging this matter upon the authorities, for he returns to it in his first report and says: "Of late years, in our country, more additions have been made to meteorol-

1 "The Smithsonian Institution: Document Relative to Its Origin and History." Edited by William J. Rhees. Page 784. Washington, 1879.

2 "A local system of meteorological observations was established in the State of New York, in 1825, and has been uninterruptedly continued from that time until the present. Each of the academies, which participated in the literature fund of the State, was furnished with a thermometer and rain gauge, and directed to make three daily observations relative to the temperature, the direction of the wind, cloudiness," etc. Joseph Henry in his paper, "Meteorology in its Connection with Agriculture," in "Agricultural Report for 1855," page 369. Among the academies where meteorological observations were taken was the Albany Academy. See also page 212, "Memorial of Joseph Henry."

3 Abbe, Cleveland, "Historical Notes on the Systems of Weather Telegraphy, and Especially Their Development in the United States." *American Journal of Science*, Volume II, page 82, August, 1871. In a footnote Abbe says, "Earlier than Franklin must have been Lewis Evans, who, according to Hon. T. Pownall, M. P., published in 1749 in Philadelphia, the brief statement of this general law." See also Lorin Blodget's "Climatology of the United States," page 379, Philadelphia, 1857.

ogy than to any other branch of physical science."[1] Then he unfolds his plan: "It is proposed to organize a system of observations which shall extend as far as possible over the North American continent."[2]

In the accomplishment of this purpose he wisely calls to his assistance "the most experienced American meteorologists,"[3] Espy and Loomis, both of whom prepared reports on the subject, which are given as appendices two and three to the first annual Report. The first, by Loomis, is a masterly summary of all the knowledge then possessed on the subject. He showed what advantages might be expected from the study of storms, what had been already done in this country toward making the necessary observations, and finally, what encouragement there was to a further prosecution of the same researches. He then presented in detail a plan for unifying the work done by existing observers, and for supplementing it by that of new observers at needed points, for a systematic supervision, and, finally for a thorough discussion of the observations collected.[4]

The communication from Espy is a shorter one, but it is of much value and specially pertinent in that it refers to his "circular to the friends of science" sent out from the Surgeon-General's office before 1843, in which he urged the keeping of meteorological journals upon voluntary observers, and requested coöperation in his efforts to develop the phases of storms. It was also in this letter that he announced his "intention to lay down on skeleton maps of the United States, by appropriate symbols, all the most important phases of great storms which might come within the range of our simultaneous observations; and thus it was hoped that we should be able to determine the shape and size of all storms;

1 "Smithsonian Report," 1846, page 25.

2 *Ibidem.*

3 Langley, S. P., "The Meteorological Work of the Smithsonian Institution." Page 217, "Bulletin No. 11 of the Weather Bureau."

4 "Smithsonian Report," 1846, page 28.

whether they are *round* or *oblong*, and if oblong whether they move *sideforemost* or *endforemost*, or *obliquely;* and to ascertain their *velocity* and *direction* in all the different seasons of the year; the *course* of the wind in and beyond the borders of the storm; the *fluctuation* of the barometer and *change* of temperature which generally accompany storms, and the *extent* to which their influence is felt beyond their borders."[1]

Henry's request, sustained by the weighty opinions of such eminent authorities, easily convinced the Board of Regents of the value of the proposition, and on December 15, 1847, that body appropriated "for instruments and other expenses connected with meteorological observations, one thousand dollars."[2] Such was the beginning of the meteorological work of the Smithsonian Institution.

With this very small appropriation it was impossible to put into active operation the plan proposed by Loomis, if indeed, such was ever the intention of Henry, and the money was properly diverted to the purchase of instruments. Without accurate appliances for the determination of observations, no true results are possible in science, and no one knew this fact better than Henry.

It was the policy of the Institution then as now to seek aid "from every quarter whence it may be obtained,"[3] and the coöperation of the meteorological services then in existence was the evident ambition of Henry. In August, 1848, Espy was appointed Meteorologist in the Navy Department, and

[1] "Smithsonian Report," 1846, page 47. See also "Memoir of Elias Loomis," by Hubert A. Newton, contained in "Smithsonian Report," for 1890, page 754, where Professor Newton calls attention to the weather maps made by Loomis in the year 1842, and points out the great similarity between the maps now in use by the Weather Bureau and those invented by Loomis. He says: "The greatest inventions are oft-times the simplest, and I am inclined to believe that the introduction of this simple method of representing and discussing the phenomena of a storm was the greatest of the services which our colleague rendered to science."

[2] Rhees, William J., "The Smithsonian Institution: Journals of the Board of Regents, Reports of Committees, Statistics, etc.," page 43, Washington, 1879.

[3] "Smithsonian Report," 1849, page 14.

in that year an appropriation was made by Congress for meteorology under the direction of the Secretary of the Navy. According to the Smithsonian Report for 1848, "in order that the observations thus established may not interfere with those undertaken by the Smithsonian Institution, that officer [the Secretary of the Navy] has directed Professor Espy to coöperate with the Secretary of the Institution." [1]

The plan had now reached that stage of development when it could be definitely formulated, and Henry continues: "It is contemplated to establish three classes of observers among those who are disposed to join in this enterprise. One class, without instruments, to observe the face of the sky as to its clearness, the extent of cloud, the direction and force of wind, the beginning and ending of rain, snow, etc. A second class, furnished with thermometers, who, besides making the observations above mentioned, will record variations of temperature. The third class, furnished with full sets of instruments, to observe all the elements at present deemed important in the science of meteorology. It is believed that much valuable information may be obtained in this way with reference to the extent, duration, and passage of storms over the country, though the observer may be possessed of no other apparatus than a simple wind-vane. With the instruments owned by private individuals, with those at the several military stations, and with the supply of the deficiency by the funds of the Smithsonian Institution, it is believed that observations can be instituted at important points over the whole United States, and that with the observations which we can procure from Mexico and the British possessions of North America, data will be furnished for important additions to our knowledge of meteorological phenomena." [2]

For the accomplishment of this plan there was required,

[1] "Smithsonian Report," 1847, page 15. [2] *Ibidem.*

first of all, a corps of meteorological observers, and a circular signed by Henry and Espy, requesting the coöperation of those interested in the subject was issued on November 1, 1848. This document was distributed by members of Congress[1] during the winter of 1848–'49, to such of their constituents as were judged to be favorable to the undertaking, including a list of all persons who, as far as they were known, had hitherto been accustomed to make meteorological observations in North America. These names were furnished by Professor James H. Coffin, of Lafayette College.[2] Coöperation was also solicited from the existing systems under the direction of the Surgeon-General and of those in the States of New York and Pennsylvania.[3]

A large number of communications were received in reply to this circular, and in February, 1849, the necessary answers were prepared and sent out with blank forms for the register of the weather. The number of persons who volunteered their assistance at that time, or from whom coöperation might be expected, was 412, of which 143 were correspondents of Professor Espy, and had been previously engaged in collecting observations under the direction of the Navy Department.[4] At once the service came into active operation, and as a result Henry was able to report in 1849 that already "from localities widely separated from each other, and distributed over the greater portion of the United States, about one hundred and fifty monthly returns are now regularly received,"[5] and "it will be seen we are in a fair way of establishing a general system of meteorology, extending over a great portion of North America, including many stations furnished with compared instruments referred to the same standard."[6]

[1] "Smithsonian Report," 1851, page 68.

[2] *Ibidem*, 1847, page 15.

[3] A system of State observation was established in Pennsylvania in 1837, by the appropriation of the sum of $4,000 by the State legislature. See Agricultural Report for 1855, page 370.

[4] "Smithsonian Report," 1851, page 68.

[5] *Ibidem*, 1848, page 12.

[6] *Ibidem*, 1848, page 15.

In 1848 Arnold Guyot came to the United States, and at the meeting of the American Association held in Philadelphia in that year he met Henry, who at once consulted him in regard to the development of the collection of meteorological observations. Guyot was charged with the selecting and ordering of the improved instruments that were required.[1] He rejected the old barometers in favor of the cistern barometer of Fortin as improved by Ernst, and further improved in accordance with his own suggestion as regards safety of transportation, resulting in the instrument made by James Green, of New York, and known as the "Smithsonian barometer." Each instrument made according to this pattern was numbered and accurately compared with a standard.[2] The set of instruments sent out consisted of a barometer, thermometer, hydrometer, wind-vane, and snow and rain gauge.[3] In the Smithsonian Report for 1850, from which so much has been quoted, Henry says: "The most important service the Smithsonian Institution has rendered to meteorology during the past year, has been the general introduction into the country of a more accurate set of instruments at a reasonable price."[4] The distribution of these sets of standard instruments accomplished much in the way of disseminating a greater knowledge of meteorology, for there were many persons who were glad to purchase them for their private use, but who were unwilling to bind themselves to the strict compliance required by the rules of the service. The result was the establishment of numerous small meteorological observatories scattered throughout the country that became local centers of scientific observation and contributed toward the development of the science.

Guyot was further intrusted with the preparation of a

[1] Dana, James D., "Memoir of Arnold Guyot," Biographical Memoirs, National Academy of Sciences, Volume II, page 338.

[2] "Smithsonian Report," 1850, page 17.

[3] *Ibidem.*

[4] *Ibidem.*

pamphlet of "Directions for Meteorological Observations,"[1] which was issued in 1850, and he was also invited to compile "A Collection of Meteorological Tables," which was issued in 1852. The latter, consisting, when first published, of only 212 pages, passed through four editions[2] under Professor Guyot, the last of which, appearing in 1884, contained 748 pages. Although designed primarily for the meteorological observers reporting to the Smithsonian Institution, the tables obtained a much wider circulation and were extensively used by a large number of meteorologists and physicists in Europe and the United States.

In 1847 Henry had recognized the value of the application of the electric telegraph[3] as "a ready means of warning the more northern and eastern observers to be on the watch for the first appearance of an advancing storm";[4] and a year later he wrote, "As a part of the system of meteorology, it is proposed to employ, as far as our funds will permit, the magnetic telegraph in the investigation of atmospheric phenomena," and then,[5] "The advantage to agriculture and commerce to be derived from a knowledge of the approach of a storm, by means of the telegraph, has been frequently referred to of late in the public journals."[6] Realizing that the time for action had arrived, Henry, in 1849, personally requested the presidents of a number of telegraph companies

[1] Dana, James D., "Memoir of Arnold Guyot," Biographical Memoirs, National Academy of Sciences, Volume 11, page 338.

[2] The second edition was issued in 1859. Concerning this volume Guyot wrote to Henry in 1858 "that two-fifths of the pages of tables, representing 68,000 computed results, were wholly new and were prepared for the volume." Also, "It is essentially a work of patience, in doing which the idea of saving much labor to others and facilitating scientific research is the only encouraging element." Dana's Memoir, page 338.

[3] In the *American Journal of Science* for September, 1846 (page 334), W. C. Redfield says: "In the Atlantic ports of the United States, the approach of a gale when the storm is yet on the Gulf of Mexico, or in the Southern or Western States, may be made known by means of the electric telegraph, which, will probably soon extend from Maine to the Mississippi." This is the first known published suggestion of the use of telegraphy for the transmission of meteorological information, and is doubtless the source from which Loomis obtained his idea, which, in turn, was passed on to Henry.

[4] "Smithsonian Report," 1846, page 25.

[5] *Ibidem*, 1848, page 15.

[6] *Ibidem*, 1848, page 16.

to allow the Smithsonian Institution "at a certain period of the day, the use of their wires for the transmission of meteorological intelligence."[1]

This request was favorably considered and thereafter, until the beginning of the civil war, the system of daily telegraphic weather reports thus inaugurated was continued. Such was the beginning of the telegraphic weather service, and by means of these reports predictions of coming storms, with all the recognized advantages to the country at large, were made possible.[2] It is of this service that Cleveland Abbe has so well said: "However frequently the idea may have been suggested of utilizing our knowledge by the employment of the electric telegraph, it is to Professor Henry and his assistants in the Smithsonian Institution that the credit is due of having first actually realized this suggestion."[3]

The next step was an important one, and in the annual Report for 1850 Henry wrote: "For the better comprehension of the relative position of the several places of observation, now embraced in our system of meteorology, an outline map of North America has been constructed, by Professor Foreman. This map is intended also to be used for presenting the successive phases of the sky over the whole country, at different points of time, as far as reported to us, and we

1 "Smithsonian Report," 1849, page 15.

2 I am not unmindful of the fact (for which I am indebted to Professor Abbe) that in March, 1848, the *American Journal of Science*, page 297, contains the following item:

"TELEGRAPHIC REPORTS OF METEOROLOGICAL PHENOMENA.

"Messrs. Jones & Co., Merchants' Exchange, New York, have made arrangements to give daily and hourly reports of meteorological phenomena, by telegraphic messages from all parts of the country which are in telegraphic communication with New York. This novel and important enterprise will furnish more extensive means of synchronous comparison of the state of the barometer, direction of the wind, and generally of all meteorological phenomena, than were ever before possessed by the scientific world. It is hoped the colleges, scientific institutions, and individuals favorably situated will combine their efforts to give efficiency to this scheme, which if properly encouraged by proper hands, cannot fail of interesting results." With this brief notice the service mentioned seems to have passed away — perhaps even before it came into existence, for no traces of it are to be found, even after a most careful search.— M. B.

3 *American Journal of Science*, Volume II, page 83, August, 1871.

have been waiting for its completion to commence a series of investigations, with the materials now on hand, relative to the progress of storms."[1]

The value of this map soon became apparent, and it is not too much to say that the ambition of Espy "to lay down on skeleton maps of the United States, by appropriate symbols, all the most important phases of great storms"[2] became an actuality under the administration of the Smithsonian Institution. As the data from various sources were received, the meteorological conditions were indicated on the map; and a current weather map was the final culmination of the idea.

It is thus described by Henry himself: "The first practical application which was attempted of the principle we have mentioned was made by this Institution in 1856; the information conveyed by telegraphic despatches in regard to the weather was daily exhibited by means of differently-colored tokens, on a map of the United States, so as to show at one view the meteorological condition of the atmosphere over the whole country. At the same time publication of telegraphic despatches was made in the newspapers."[3] This map was hung where the public could have general access to it to observe the changes, and its indications were first published at large by signals displayed from the high tower of the Institution.[4]

The annual Report for 1858 describes it somewhat in detail. It says: "An object of much interest at the Smithsonian building is a daily exhibition on a large map of the condition of the weather over a considerable portion of the United States. The reports are received about ten o'clock in the morning, and the changes on the maps are made by temporarily attaching to the several stations pieces of card of different

[1] "Smithsonian Report," 1850, page 19.

[2] Page 651, this volume.

[3] "Scientific Writings of Joseph Henry," Volume II, page 453, being an extract from the "Smithsonian Report" for 1865, page 56.

[4] Langley, S. P., "The Meteorological Work of the Smithsonian Institution," page 219, "Bulletin No. 11 of the Weather Bureau," being a "Report of the International Meteorological Congress," held in 1893.

colors to denote different conditions of the weather as to clearness, cloudiness, rain, or snow."[1] Soon an improvement followed by the adoption of circular disks of different colors, which were attached to the maps by pins at each station of observation, and indicating by their color the state of the atmosphere, white signifying clear weather; gray, cloudy; black, rain; etc. The disks had an arrow stamped upon them, and as they were so arranged that they could be attached to the map in any direction, the motion of the wind at each station was shown by them.[2] Henry wrote: "This map is not only of interest to visitors in exhibiting the kind of weather which their friends at a distance are experiencing, but is also of importance in determining at a glance the probable changes which may soon be expected."[3]

It was also in 1856, to again quote Henry, that "several of the observers publish the results of their observations in the newspapers of their vicinity," concerning which, he adds: "We would commend this custom to general adoption."[4] With the growth of the telegraph came also a development of its usefulness to the meteorological work of the Smithsonian Institution, and the next step was the publication in the daily newspapers of the telegraphic reports of the weather. In 1857 Henry acknowledges his indebtedness "to the National Telegraph line for a series of observations from New Orleans to New York, and as far westward as Cincinnati, Ohio, which have been published in the 'Evening Star' of this city. These reports have excited much interest, and could they be extended further north, and more generally to the westward, they would furnish important information as to the approach of storms. We hope in the course of another year to make

[1] This description is from "Smithsonian Report," 1858, page 32.

[2] Langley, S. P., "The Meteorological Work of the Smithsonian Institution," page 219, "Bulletin No. 11 of the Weather Bureau."

[3] "Smithsonian Report," 1858, page 32.

[4] *Ibidem*, 1856, page 35.

such an arrangement with the telegraph lines as to be able to give warning on the eastern coast of the approach of storms, since the investigations which have been made at the Institution fully indicate the fact that as a general rule the storms of our latitude pursue a definite course."[1] The last quotation shows the results accomplished by the meteorological service of the Smithsonian Institution. That storms pursue a definite course was now an established fact, and the proposition of Franklin that the storms of the southeast advance in a northeasterly direction was recognized as a law. Of practical value is the acknowledgment that the announcement of the progress of storms by the telegraph had been accomplished, while the original simultaneous publication in the newspapers and on a daily weather map of their advance are incidental results in the development of the science. "It will thus be seen that without material aid from the government, but through the enlightened policy of the telegraph companies, and with the assistance of the munificent bequest of James Smithson, 'for the increase and diffusion of knowledge,' the Smithsonian Institution, first in the world, organized a comprehensive system of telegraphic meteorology, and has thus given first to Europe and Asia, and now to the United States, that most beneficent national application of modern science, the Storm Warnings."[2]

In that which has preceded an attempt has been made to show the development of the meteorological work of the

[1] "Smithsonian Report," 1857, page 26.

[2] Abbe, Cleveland, *American Journal of Science*, Volume II, page 85, August, 1871. The following from Norton's *Literary Register and Book-Buyers' Almanac* for 1853, page 49 is also pertinent as shown in the workings of the Smithsonian at that time: "No institution or government in the world is now doing anything like as much for meteorology as the Smithsonian. It has planned and executed the great system of observations, has imported standard instruments, and rated and constructed hundreds of barometers and thermometers used all over the continent. It has published full directions for observing, has now in press a series of hygrometrical, barometrical, hypsometrical and many other tables of prime importance, amounting to upward of three hundred pages. This and much more for meteorology alone."

Smithsonian Institution in the direction of reporting the condition of the weather. That was not its only function. In an excerpt from the "Transactions of the American Medical Association," quoted by Henry, is the following description: "The primary object of the Smithsonian Institution is the advancement of the science of meteorology and the elucidation of the laws of atmospheric phenomena; that of the Patent Office, to collect facts and deduce therefrom laws which have immediate reference to agriculture; while the system of the Medical Department is intended to be primarily subservient to the health of the troops and the advancement of medical science. These three Institutions are now in harmonious coöperation, and it is believed that it is no exaggeration to say that under their auspices more is now being done to advance meteorology than has ever before been attempted under any government."[1] Of the work accomplished by the Patent Office a few words are necessary. From 1854 to 1860 an annual appropriation was made by Congress for "the collection of agricultural statistics, investigations for promoting agriculture and rural economy, etc."[2] A portion of this income during the years mentioned was devoted by the Commissioner of Patents to assisting the Smithsonian Institution in collecting and reducing meteorological observations. Charles Mason, who was Commissioner of Patents in 1853–'57, says in his Report for 1856 "that the degree of heat, cold, and moisture in various localities, and usual periods of their occurrence, together with their effects upon different agricultural productions, are of incalculable importance in searching into the laws by which the growth of such products is regulated, and will enable the

[1] Preface of "Results of Meteorological Observations made under the direction of the United States Patent Office and the Smithsonian Institution from the year 1854 to 1859 inclusive, being a report of the Commissioner of Patents made at the first session of the Thirty-sixth Congress," Volume I (1861).

[2] "Smithsonian Report," 1860, page 34.

agriculturist to judge with some degree of certainty whether any given article can be profitably cultivated."[1]

It was with this congenial coöperation that in 1855 a new set of blank reports were prepared by, and distributed under, the frank of the Patent Office. They were also returned, when filled out, to Washington, under a similar frank, thus accomplishing a large saving in the item of postage. From the Smithsonian Institution the registers were sent to Professor James H. Coffin, of Lafayette College, and by him they were reduced and discussed. According to the annual Report of 1857 "from twelve to fifteen persons, many of them females, have been almost constantly employed, under the direction of Professor Coffin, in bringing up the arrears, and in reducing the current observations."[2] Some idea of the enormous amount of work involved may be gathered from the following statement contained in the Report for 1857: "During 1856 the records of upwards of half a million of separate observations, each requiring a reduction involving an arithmetical calculation, were received at the Institution. Allowing an average of one minute for the examination and reduction of each observation, the amount of time consumed will be nearly 7,000 hours, or, at the rate of seven hours per day, it will be 1,000 days or upwards of three years, or, in other words, to keep up with the reduction of the current observations the whole available time of three expert computers is required. This is independent of the labor expended in the correspondence, preparation and distribution of blank forms, and the deduction of general principles."[3] This was subsequently increased quite materially, and while in 1854 there were 234 stations, in 1856 there were 320 and in 1859 the number had increased to 531.[4]

[1] Quoted in "Smithsonian Report," 1860, page 34, where the entire subject is fully discussed.

[2] "Smithsonian Report," 1857, page 28.

[3] *Ibidem*, 1857, page 27.

[4] *Ibidem*, 1861, page 36.

In the annual Report for 1860 it appears that the appropriation from the Commissioner of Patents was "suddenly and unexpectedly suspended,"[1] so that thereafter it was impossible to continue the reduction of the results. Fortunately, however, the general results of all the observations for six years had already been presented to Congress in the joint name of the Smithsonian Institution and the Patent Office, and were in the hands of the Public Printer. The first volume, with the title of "Results of Meteorological Observations made under the direction of the United States Patent Office and the Smithsonian Institution from the year 1854 to 1859 inclusive, being a Report of the Commissioner of Patents made at the First Session of the Thirty-sixth Congress," was published in 1861.[2]

The second volume of these "Results of Meteorological Observations" was issued in 1864, and, although it bore the same title as the earlier volume, the subject matter was entirely different, for it consisted chiefly of a digest of "Observations upon Periodical Phenomena in plants and animals from 1851 to 1859, with tables of the dates of opening and closing of lakes, rivers, harbors, etc.,"[3] arranged by Doctor Franklin B. Hough, and also a critical study of three storms of 1859 made from data collected from the records in the institution and prepared for publication by Professor James H. Coffin, of Lafayette College.

The first of the three papers demands more careful consideration. Mention has already been made of the blanks sent out in 1817 by Josiah Meigs when in charge of the Land Office, calling for information concerning the time of the unfolding of the leaves of plants, the time of flowering, the immigration of birds whether from North or South; the im-

[1] "Smithsonian Report," 1860, page 34.

[2] A discussion of its contents together with an account of the work accomplished during the year in meteorology appears on page 36 of the "Smithsonian Report" for 1861.

[3] "Smithsonian Report," 1864, page 25.

migration of fishes; and similar information. No continuous record of the results collected by Meigs has ever been published, and it is not even definitely known what became of the originals after his death in 1822.[1] It remained for the Smithsonian Institution to revive the collection of such information, and therefore in 1851 a circular entitled "Registry of Periodical Phenomena" was sent to all of its observers. It was prepared by Doctor John Torrey and Doctor Edward Foreman and gave a list of plants to be observed for the period of flowering and fruiting. Later the circular was made to include information concerning phenomena of animal life. The gathering of such facts was continued until 1859, and the material was then tabulated by Doctor Hough. He classified the observations under the following headings: Dates of foliation or leafing of plants; dates of blossoming of plants; dates of ripening of fruits; dates of defoliation or fall of leaf in plants; dates of first appearance of birds; dates of first appearance of other animals (reptiles, fishes, and insects), and a series of miscellaneous records, having to do chiefly with the opening and closing of navigation at certain stations. Doctor Hough in the introduction says: "These results will be found to have a more direct application to meteorological science, by indicating the progress of the seasons in different localities, and their relative variability in different years. For this purpose plants and animals afford indications as significant as meteorological instruments as to temperature, and other climatic conditions, because strictly dependent upon them, and in the absence of all other records they would furnish a reliable chronicle of the passing year."[2] At the time of the publication of this second volume, Henry said: "These two quarto volumes of meteorological results for the

[1] Henry, Alfred J., "Early Individual Observers in the United States," page 301, "Bulletin No. 11 of the Weather Bureau," being a "Report of the International Meteorological Congress." Washington, 1895.

[2] Page 6 of the introduction.

six years 1854 to 1859 inclusive, embracing nearly two thousand pages, together with a volume covering very nearly the same period of time published by the War Department, probably form an unsurpassed body of materials for the investigation of meteorological phenomena over so wide an extent of country."[1]

The corps of observers was in many respects a remarkable body, and a cursory examination of the list shows the names not only of men eminent in science at that time, but also of men who have since become noted, and perhaps whose first contributions to science consisted in meteorological observations. The training that was thus acquired developed the powers of close observation and had much to do with the success of the individual that came later. Indeed it could hardly be otherwise. Only a student of nature would be intrusted with the proper filling out of the "Registry of Periodical Phenomena." The botanist would watch for the first budding of plants, and the young naturalist would be equally alert to record new facts in regard to animal life. A few names taken from the hundreds on record are therefore of special interest. They include Cleveland Abbe, Michigan, 1;[2] Major J. W. Abert, South Carolina, 1; Spencer F. Baird, Pennsylvania, 1; Frank Baker, Illinois, 2; Adolf F. Bandelier, Illinois, 5; William M. Beauchamp, New York, 9; Lorin Blodget, Pennsylvania, 3; William C. Bond, Massachusetts, 4; Parker Cleaveland, Maine, 4; John L. Campbell, Virginia, 2; Alexis Caswell, Rhode Island, 18; John Chappelsmith, Illinois, 22; P. A. Chadbourne, Massachusetts and Connecticut, 2; George H. Cook, New Jersey, 5; Doctor Elliott Coues, Arizona, 1; W. H. Dall, Alaska, 2; Reverend J. Owen Dorsey, Dakota, 1; John D. Easter, Georgia, 3; Doctor George Engelmann,

1 "Smithsonian Report," 1864, page 26.

2 This figure indicates the number of years during which continuous observations were carried on.

Missouri, 14; M. C. Fernald, Maine, 4; L. R. Gibbes, South Carolina, 1; Donald Gunn, British America, 5; C. F. Hartt, Nova Scotia, 2; Jed Hotchkiss, Virginia, 7; Charles A. Joy, New York, 6; Alexis A. Julien, Antilles and New York, 4; Robert C. Kedzie, Michigan, 11; W. C. Kerr, North Carolina, 2; Jared P. Kirtland, Ohio, 1; S. A. Lattimore, New York, 1; Increase A. Lapham, Wisconsin, 20; Captain John Henry Lefroy, Canada, 3; W. W. Mather, Ohio, 3; Alfred M. Mayer, Maryland and Pennsylvania, 5; J. Meehan, Pennsylvania, 15; Marshall Macdonald, West Virginia, 1; W. A. Norton, Delaware, 1; David D. Owen, Indiana, 4; Reverend Roswell Park, Wisconsin, 1; Henry W. Ravenel, South Carolina, 5; Professor Orin Root, New York, 1; Charles Sartorius, Mexico, 14; A. P. S. Stuart, Nova Scotia and Illinois, 6; James M. Tower, New York, 3; Bela White, Nebraska, 4; R. B. Warder, Ohio, 2; Alexander Winchell, Alabama, 2; Theodore G. Wormley, Ohio, 2; Charles A. Young, Ohio, 6; and Ira Young, New Hampshire, 2.

Among those who reported on periodical phenomena in plants and animals were not only many of the foregoing, but also the following well-known names: James G. Cooper, Washington Territory; William Darlington, Pennsylvania; Chester Dewey, New York; Franklin B. Hough, New York; Robert W. Kennicott, Illinois; A. S. Packard, Jr., Maine; F. Peyre Porcher, South Carolina; John M. Ordway, Missouri, and N. B. Webster, Virginia.

Of these men Baird has well said:

"The interest of the observers was maintained by a constant correspondence with the Institution. Copies of the Smithsonian Reports and other publications were duly transmitted to them, and any inquiries or communications from them on scientific subjects were promptly responded to. In this way a body of collaborators was secured to the Institu-

tion, whose services cannot be overestimated, since they not only furnished information relating to meteorology, but they were always ready to supply information and assistance in other directions. To that body of men the National Museum owes a very large part of the extensive and complete series of illustrations of North American natural history that gives to it so great a prominence, this being the result of successive applications for aid from particular classes. Thus, whenever the attention of the Institution was directed to the fact that some particular branch of natural history required its fostering care, circulars were prepared and issued to the meteorological correspondents, invoking coöperation, and asking them to collect objects of the kind that might be found in their neighborhood, so that, not only all North American species might be gathered, but accurate determinations made of their geographical distribution. Very extensive responses usually followed these appeals, and in many cases sufficient material was secured to place the subject on a permanent and satisfactory basis. The works of the Institution on many orders of insects and on fresh-water and land shells, reptiles, birds, mammals, etc., were all based more or less entirely on collections and information obtained by the Smithsonian observers.

"As a result, therefore, of over twenty-five years' observations by such men, the mass of meteorological information obtained became very great, and even though a certain per cent. of the observations could not lay claim to that minute accuracy which is generally required, yet it was found that, for many purposes, such as the general indications of variations in temperature, barometrical pressure, rainfall, etc., in the collation of all observations the errors disappeared, and an average was secured which did not differ essentially from what would have been derived from more accurate observations."[1]

The Smithsonian Institution is also entitled to credit for gathering the following material relating to the climate of the

[1] "Smithsonian Report," 1878, pages 25, 26.

North American continent: 1. A miscellaneous collection of manuscripts and other tables relative to the climate of the United States; 2. The observations made under the direction of the Smithsonian Institution subsequent to 1849; 3. A series of observations made by Doctor Luis Berlandier in Mexico; 4. Observations made in the British Possessions; 5. The record of observations made by government and other exploring expeditions; 6. Copies of the observations made under the direction of the Surgeon-General at the military posts; 7. Copies of the observations made at the expense of the States of New York, Massachusetts, Pennsylvania, Maine, and Missouri; and 8. A series of observations from Bermuda and the West Indies.[1] It was intended to systematically arrange and reduce these observations so that the results might be summarized into general laws, but the civil war put an end to such work, and ultimately the collected material was transferred to the custody of what is now the Weather Bureau.

Certain special meteorological investigations were also carried on in the Institution. During 1850 Espy conducted a series of experiments on the variations of temperature produced by a sudden change in the density of atmospheric air. The investigation was carried on in one of the rooms of the Smithsonian Institution "with articles of apparatus belonging to the collection which constituted the liberal donation of Doctor Hare."[2] It was during the same year that a special circular was issued to the observers asking for information relating to the aurora, and a valuable collection of returns was received, which were placed in the hands of Captain J. Henry Lefroy, then in charge of the meteorological work in Toronto, to be "incorporated with observations of a similar kind, which he had collected in the British

[1] "Smithsonian Report," 1857, page 65.
[2] *Ibidem*, 1850, page 16.

Possessions of North America."[1] Another early illustration of meteorological investigation may be mentioned: Soon after the occurrence of an earthquake in the central part of the United States on April 29, 1852, a circular was issued, requesting a report of any observations which had been made or could be gathered relative to that event. Numerous replies were received, embodying facts sufficient to enable the Institution to mark the point of chief intensity and trace out the diverging lines along which the earth-wave passed.[2]

Bare mention must be made of the reduction of the series of Temperature Tables begun in 1851 by Lorin Blodget; and also of Tables of Precipitation. Ultimately the entire mass of material, excepting of course that which was published under the joint auspices of the Smithsonian Institution and the Patent Office, was given into the hands of Charles A. Schott for reduction and discussion. Three volumes resulted, of which the first, issued in 1872, consisted of "Tables and Results of the Precipitation in Rain and Snow in the United States, and at some stations in adjacent parts of North America, and in Central and South America."[3] The second was issued in 1876 and bore the title of "Tables, Distribution, and Variations of the Atmospheric Temperature in the United States and some adjacent parts of America."[4] A third volume, issued in 1881, was essentially a reprint of the first and had for its title "Tables and Results of the Precipitation in Rain and Snow in the United States, and at some stations in adjacent parts of North America, and in Central and South America."[5] It is manifestly impossible at this place to attempt any discussion of the contents of these volumes, but it is suggestive of the magnitude of the undertaking to repeat from the preface

1 "Smithsonian Report," 1850, page 19.

2 *Ibidem*, 1852, page 74.

3 *Ibidem*, 1872, page 21.

4 The character and extent of this work are discussed at length on page 23 of the "Smithsonian Report," 1875.

5 See description on page 26 of "Smithsonian Report," 1881.

of one of them[1] that of the eight sources of information from which the tables were derived, the 300 and over folio volumes of the registers of the Smithsonian Institution was a single source. They were published in the Contributions to Knowledge. In this connection mention must be made of the "Three Rain Charts of the United States, showing the distribution by Isohyetal lines of the mean precipitation in rain and melted snow: (1) for the summer months, (2) for the winter months, (3) for the year" (1870); "Temperature Chart of the United States, showing the distribution, by isothermal lines, of the mean temperature for the year" (1873); "Three Temperature Charts of the United States, showing the distribution by isothermal curves of the mean temperature of the lower atmosphere: (1) for the summer months, (2) for the winter months, (3) for the year" (1874); "Temperature Chart of the United States, showing the distribution of isothermal lines of the mean temperature for the year (1874); and a Base Chart of the United States" (1880). All of which were published by the Smithsonian Institution in the years indicated by the parenthesis.

Mention has already been made of the valuable collection of Meteorological Tables, by Arnold Guyot, the fourth edition of which was published in 1884. This edition was exhausted in a very few years, and Secretary Langley then decided to recast the work entirely and publish it in three parts, one of meteorological, one of geographical, and one of physical tables, each representative of the latest knowledge in the field and independent of the others, but the three forming a homogeneous series. The "Smithsonian Meteorological Tables," the first volume of the new series was issued in 1893.[2]

Among the early volumes of the "Contributions to Knowledge" are numerous papers containing discussions of meteor-

1 "Smithsonian Report," 1875, page 25.

2 *Ibidem*, 1894, page 9.

ological observations. They include the series made by Alexander D. Bache, in the Girard College Observatory, in Philadelphia, during 1840–'45 and were published in six parts issued between the years 1859 and 1865;[1] those made by Doctor Alexis Caswell in Providence, Rhode Island, from December, 1830, till December, 1876;[2] those made by Parker Cleaveland in Brunswick, Me., during 1807–'59;[3] those made by Samuel P. Hildreth and Joseph Wood from 1817 to 1823 and from 1826 to 1859,[4] and those made by Doctor Nathan D. Smith in Washington, Ark., from 1840 to 1859.[5]

The meteorological observations made in the Arctic regions were all reduced and discussed by Charles A. Schott. They included those gathered by Elisha K. Kane during 1853–'55;[6] those collected by Sir Francis L. McClintock during 1857 and 1859;[7] and last of all, those obtained by Doctor Isaac I. Hayes during 1860–'61.[8]

Of more special meteorological interest are the following memoirs, likewise contained in the Smithsonian publications, and for the most part written by scientists who were also included among the staff of observers. They include "Winds of the Northern Hemisphere," by James H. Coffin (1853);[9] "Account of a Tornado near New Harmony, Indiana, April 30, 1852," by John Chappelsmith (1855);[10] "On the Recent Secular Period of the Aurora Borealis," by Dennison Olmsted

1 Full descriptions of these parts may be found on page 18 "Smithsonian Report," 1859; page 26 "Smithsonian Report," 1860; page 17 "Smithsonian Report," 1862; page 16 "Smithsonian Report," 1863; and page 18 "Smithsonian Report," 1864.

2 See "Smithsonian Report," 1859, page 31; "Smithsonian Report," 1860, page 21; and "Smithsonian Report," 1882, page 21, for description.

3 See "Smithsonian Report," 1867, pages 23 and 28, for description.

4 See "Smithsonian Report," 1867, page 32, for detailed description.

5 See "Smithsonian Report," 1860, page 22, for detailed description.

6 See "Smithsonian Report," 1859, page 22, for detailed description.

7 See "Smithsonian Report," 1861, page 16, for detailed description.

8 See "Smithsonian Report," 1865, page 26, for description.

9 This most important work costing many years' labor is described in the "Smithsonian Report," 1851, page 12, and "Smithsonian Report," 1853, page 13.

10 See "Smithsonian Report," 1853, page 14, for analysis.

(1856);[1] "Record of Aurora Phenomena observed in the Higher Northern Latitudes," by Peter Force (1856);[2] "On Certain Storms in Europe and America," by Elias Loomis (1860);[3] "The Orbit and Phenomena of a Meteoric Fire Ball seen July, 1860," by James H. Coffin (1869),[4] and "The Winds of the Globe," by James H. Coffin (1875).[5] To this splendid collection of meteorological works there might well be added certain smaller monographs that are contained in the Miscellaneous Collections and Smithsonian Reports, but space is wanting.[6] In the series of Records of Scientific Progress, meteorology was not neglected, and from 1879 till 1884[7] the admirable summaries of this science that were contributed to the Smithsonian Reports were from the able pen of Professor Cleveland Abbe.

With the beginning of the civil war came the loss of the appropriation by means of which it had been up to that time possible to secure the reduction of the observations. At the same time the telegraphic service became unsatisfactory. In the annual Report for 1860 Henry says: "We regret that frequent intermissions take place in the receipt of the telegrams from places directly west of the city of Washington, especially as we are more immediately interested in these, since they afford the means of predicting with considerable certainty the character of the weather sometimes a day or more in advance."[8] A year later the popular system of daily telegraphic reports of the condition of the weather from distant parts of the United States had been discontinued; "the

1 See "Smithsonian Report," 1854, page 12, for analysis.

2 *Ibidem.*

3 See "Smithsonian Report," 1859, page 28, for detailed description.

4 See "Smithsonian Report," 1868, page 49, for description.

5 See "Smithsonian Report," 1875, page 20, for detailed description.

6 "The Scientific Writings of Joseph Henry" contain his Meteorological Essays and cover more than 400 pages, and consist chiefly of those published during the years 1855–'59.

7 These were contained in the annual Reports for 1881, 1882, 1883, 1884, and 1885, and were also issued as separates.

8 "Smithsonian Report," 1860, page 36.

continuity of the lines to the South having been interrupted, and the wires from the North and West being so entirely occupied by public business that no use of them could be obtained for scientific purposes."[1]

Toward the close of 1862 "the daily telegraphic bulletin of the state of the weather"[2] was partially resumed, and in 1864 an important addition to the means at the command of the Institution for meteorological purposes was received by the liberal action of the North American Telegraphic Association, which gave the free use of all its lines for the scientific objects of the Institution. "The association embraces the Western Union, the American, the Montreal, the Southwestern, and the Illinois and Mississippi Telegraph companies, covering the entire United States and Canada, including the overland line to San Francisco, which, by its charter, is required to transmit without charge scientific despatches for the Institution."[3] The same report adds that "the telegraph companies on the Pacific Coast have also liberally granted the same privileges."[4]

In 1863 came the culmination of the misfortunes that already so seriously interfered with the development of the meteorological service. It came in the way of a law passed by Congress which prevented "the correspondents on agriculture and meteorology from sending their reports by mail unless prepaid."[5] Henry adds: "This arrangement almost entirely stops the reception of these articles, for, since the service rendered is gratuitous, the observers cannot be expected to bear this additional burden." Also, "owing to this restriction, the number of meteorological registers received during the past year has been diminished, and the transmission of nearly all of them would have been discontinued had

[1] "Smithsonian Report," 1861, page 35.

[2] *Ibidem*, 1862, page 29.

[3] *Ibidem*, 1864, page 28.

[4] *Ibidem*.

[5] See "Smithsonian Report," 1863, page 31, where the entire subject is discussed.

not the Commissioner of Agriculture, in view of their value to his department, decided to advance to some of the observers the necessary postage stamps to affix to their registers."[1]

This condition of affairs was not long continued, and the law was changed so that the meteorological registers could be sent to the Commissioner of Agriculture without payment of postage. With the organizing of the Department of Agriculture and the appointment of a commissioner interested in the collection of meteorological statistics, it was decided to begin the publication of "a monthly bulletin giving the state of the crops, the conditions of the weather and various other items of importance which are daily received from observers, and which would lose a considerable portion of their value were they suffered to remain unpublished until the end of the year." For this bulletin the Smithsonian Institution supplied "the meteorological materials, consisting of the mean, maximum, and minimum temperature and amount of rain for each month in different States, and also, for the purpose of comparison, the mean temperature and amount of rain for a series of five years, grouped by States; together with tables of important atmospheric changes, and notices of auroras, meteors, and other periodical phenomena."[2]

Step by step the history of the meteorological work of the Smithsonian Institution has been traced in these pages from its inception down to the beginning of 1866. In the Report for 1865 Henry summarizes the work accomplished in the following succinct manner:

"The Smithsonian meteorological system was commenced in 1849, and, with occasional aid in defraying the expenses, has continued in operation until the present period. It was, how-

[1] "Smithsonian Report," 1863, page 32.

[2] *Ibidem*, 1863, page 33. This Monthly Bulletin of the Agricultural Department was discontinued in 1871, by order of Commissioner Watts. See "Smithsonian Report," 1871, page 105.

ever, much diminished in efficiency during the war, since from the Southern States no records were received, and many of the observers at the North were called to abandon such pursuits for military service in the field. The efforts of the institution in this line have been directed to supplementing and harmonizing all the other systems, preparing and distributing blank forms and instructions, calculating and publishing extensive tables for the reduction of observations, introducing standard instruments, and collecting all public documents, printed matter, and manuscript records bearing on the meteorology of the American continent, submitting these materials to scientific discussion and publishing the results. In these labors the Institution has been in continued harmonious coöperation with all the other efforts made in this country to advance meteorology, except those formerly conducted by the Navy Department under Lieutenant Maury."[1]

The reëstablishment of the meteorological observations interrupted by the civil war was somewhat impeded by the fire that occurred in 1865 destroying very many of the records and instruments. This catastrophe naturally diverted funds from the meteorological work owing to the expenses incurred for repairs, so that beyond the gradual restoration of the service nothing worthy of note occurred subsequent to 1866. It may even be mentioned that during 1867 the attempt made by the Institution to resume by the coöperation of the telegraph lines the system of telegraphic indications of the weather, which was interrupted by the war, was unsuccessful. "Indeed," says Henry, "it can scarcely be expected that without some remuneration to the companies, the use of the telegraphic wires and the time of the operators should be given for the purpose."[2]

Meanwhile agitation was being created in favor of "a me-

[1] It is proper to say that the quotation continues: "These were confined exclusively to the sea, and had no reference to those made at the same time on land," "Smithsonian Report," 1865, page 52.

[2] "Smithsonian Report," 1867, page 28.

teorological department under one comprehensive system with an adequate appropriation of funds." In 1865 Henry wrote: "The present would appear to be a favorable time to urge upon Congress the importance of making provision for reorganizing all the meteorological observations of the United States under one combined plan, in which the records should be sent to a central depot for discussion and final publication. An appropriation of $50,000 annually for this purpose would tend not only to advance the material interest of the country, but also to increase its reputation. It would show that although the administration of our government is the expression of the popular volition, it is not limited in its operation merely to objects of instant or immediate utility, but that, with a wise prevision of the future, it withholds its assistance from no enterprise, however remote the results, which has for its end to advance the well-being of humanity." [1]

It was not, however, until 1869 that Congress took final action on this matter. During the winter of that year Hon. Halbert E. Paine, of Wisconsin, secured the passage of a joint resolution creating the Weather Bureau of the United States Signal Service. This resolution was approved on February 9, 1870. It appropriated $25,000 for "taking meteorological observations at the military stations in the interior of the continent, and at other points in the States and Territories of the United States, and for giving notice on the Northern Lakes and the seacoast of the United States by magnetic telegraph and marine signals of the approach and force of storms." [2] The general direction of this service was given to General Albert J. Myer.

In the Report for 1870 Henry expresses his gratification at the culmination of his desires by the creation of the new

[1] "Smithsonian Report," 1865, page 57.

[2] Abbe, Cleveland, "The Meteorological Work of the United States Signal Service 1870 to 1891." "Bulletin No. 11, Weather Bureau," page 236. Report of Meteorological Congress held in Chicago, 1893.

Weather Bureau. He suggests that "a still larger appropriation be made by Congress to the War Department for establishing, besides the reports for weather signals, a series of intermediate stations, also furnished with compared instruments, to record daily observations to be transmitted to Washington weekly or monthly, and also that provision be made for the support of a number of competent persons to carry on the reductions and prepare the results for publication."[1] And in conclusion he says: "It has been the policy of this Institution from the first to do nothing which can be done as well or better by other means, and in accordance with this policy the Institution would willingly relinquish the field of meteorology, which it has so long endeavored, though imperfectly, to cultivate, turning over to the Signal Office all the material which it has accumulated up to a given epoch."[2] The transfer of the meteorological work of the Smithsonian Institution alluded to in the foregoing paragraph was accomplished in 1873, and in the Report for that year Henry refers to it as follows: "This transfer, which has just been made, we trust will meet the approbation of the observers generally, and we hope they will continue their voluntary coöperation, not with the expectation of being fully repaid for their unremitted labor, in many cases for a long series of years, but from the gratification which must result from the consciousness of having contributed to increase the sum of human knowledge."[3]

The work of publishing the results obtained by the reduction of meteorological observations continued, and for the most part these have been specifically mentioned elsewhere in this chapter. As a contribution to the physical part of the science, Doctor Langley's "Internal Work of the Wind" may be cited as "the last word" on this important subject.

1 "Smithsonian Report," 1870, page 44.
2 *Ibidem.*
3 On page 31 of the Report for 1873, the details of the transfer are given.

In 1891 Secretary Langley deposited in the United States Signal Office all the voluminous monthly records of the Institution and all the manuscripts and printed observations relating to meteorology, subject to recall, but with the understanding that the entire official record of research and progress in this connection should be preserved intact by that office, now the Weather Bureau, which has these investigations in charge.[1]

[1] "Smithsonian Report," 1891, page 13.

PALEONTOLOGY

By Edward Drinker Cope

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BOTH in its quarto and octavo publications the Smithsonian Institution has made important contributions to the literature of the science of paleontology. A number of able paleontologists have been associated with it, and since the establishment of the United States Geological Survey, its paleontologists have been among the honorary curators of the United States National Museum.

The publications of the Smithsonian Institution concerning the fossil flora of the United States date from 1882. The first works issued were Lesquereux' "Miocene Flora of Alaska" and Newberry's "Tertiary Fossil Plants from Western North America," both of which appeared in the "Proceedings of the United States National Museum" for that year. Lesquereux' descriptions and determinations of the material then in the National Museum were published from 1887 to 1890, inclusive. It was at this time, also, that Frank H. Knowlton's interesting studies in paleobotany were issued in a series of papers, beginning in 1888. The first of these relates to material which came from the vicinity of Fort Win-

gate, New Mexico, consisting of three specimens of fossilized tree trunks. The specimens were described as a new species, and called *Araucarites Arizonicum.*

The second paper, issued in 1888, is founded on coniferous specimens, and describes two species of the genus *Cupressinoxylon.* The horizon of one of the species is probably Cretaceous, the other is Laramie.

A third paper, published in 1889, embraces descriptions of fifty species of the genus *Araucarioxylon* of Kraus, with compiled descriptions and partial synonymy of the species. As the evidence which has led to the separation of Cordaites is of interest, Knowlton presents it in full.

Descriptions of new species of fossil plants from the Fort Union group of Montana appeared in 1893, and a review of the extinct flora of Alaska in 1894.

The latter paper gives a historical review of works and papers relating to the fossil flora of Alaska, and incidentally shows the geographical distribution of the plant beds. This is followed by a systematic enumeration of the fossil plants, with descriptions of new species from Herendeen Bay, a table showing the distribution of the plants in other parts of the world; and, finally, a discussion of the geological age of the beds as indicated by the plants.

Other important works during this period were Lester F. Ward's "Paleontologic History of the Genus Platanus," published in 1888, and Holm's "Notes on the Leaves of Liriodendron," issued in 1890. The object of the latter is to prove that there is no greater difference in the foliage between many of the extinct species of Liriodendron than between a series of leaves from a very young tree or from a branch of an older plant of recent species.

The list of paleobotanical papers published up to date ends with D. P. Penhallow's "Notes on Some Devonian Plants from

the Eastern United States" (1893); W. M. Fontaine's "Descriptions of Fossil Plants from the Great Falls Coal Field, Montana" (1892); and notes by the same author on "Fossil Plants from the Trinity Division of the Comanche Series in Texas" (1893). The species described in the latter paper are known as the Glen Rose fossils. From a tabular statement it is seen that all the species of Glen Rose fossils hitherto known occur in the Lower Cretaceous, ranging from the Wealden to the Urgonian. The Potomac includes both these epochs. Omitting the species that have no value for fixing the age of the flora, because they are not sufficiently characterized, the author has nineteen for comparison. Four of these are peculiar to the Trinity division; of the fifteen remaining, no fewer than twelve are identical with plants from the older Potomac, or so near them that nearness in age of the two formations is extremely probable. The circumstances under which the basal Trinity beds were laid down indicate that the fossils entombed in them form a portion of a flora that was established on the land that was encroached upon by the Trinity sea. It is probable that this same flora extended northward to Virginia, where, somewhat later, it was preserved by a similar encroachment.

The publications on invertebrate animals antedate those concerning fossil flora by almost a score of years, the record showing that Meek's check-lists of North American invertebrate fossils were issued in 1864. These form part of the "Miscellaneous Collections," and consist of check-lists of all the species of Cretaceous, Jurassic, and Miocene invertebrate fossils of North America which had been described up to the end of 1863. They constitute an important aid in the labor of cataloguing and labeling collections. Meek's lists were supplemented by those of Conrad in 1866, and his in turn by Marcou in 1885 and 1886.

Conrad's work contains a list of all the species from the Eocene formations of North America up to its publication, and is intended to facilitate the distribution of duplicate specimens, while Marcou listed the Mesozoic and Cenozoic invertebrate types in the collections of the National Museum.

These different series of check-lists have fully answered the purpose intended, in supplying a want long felt by students of natural history.

The year 1865 is marked by two important publications: Leidy's "Cretaceous Reptiles," which will be referred to again, and Meek and Hayden's report on the "Paleontology of the Upper Missouri."

The latter work is in quarto form, and contains figures and descriptions of the various geological formations of Idaho, Dakota, Nebraska, and portions of Kansas. About three hundred and seventy species of invertebrates, nearly all of which are new, are fully described, and the descriptions are accompanied by remarks on the relations of each species to allied forms from other districts in this country and Europe, both living and fossil — their geological range and geographical distribution. The illustrations consist of about one thousand figures, occupying forty-five quarto plates.

A considerable number of the specimens described and figured were collected by Doctor F. V. Hayden in the several expeditions into the regions of the Upper Missouri and Yellowstone, sent by the government under the command of Lieutenant G. K. Warren, of the United States Topographical Engineers, to whose scientific zeal and liberal encouragement science is indebted for much of the material upon which the work is founded. But besides these, a large number were collected by Doctor Hayden himself, previous to his connection with the exploring expeditions of the government. The specific descriptions of the fossils described in this work are

to be regarded as appearing in the joint names of Meek and Hayden, while the descriptions of the genera and families, and the discussion of their relations, geological range, and geographical distribution, are by Meek.

From 1865 to 1878 there is another period during which paleontological publication ceased. During this time, however, specialists in this province were not idle. Dall was working up the Plistocene and other Tertiary invertebrate fauna of California, and his results, embodied in three separate papers, were published in 1878 in the "Proceedings." Later communications by Dall to the same medium, entitled "A Subtropical Miocene Fauna in Arctic Siberia," "A Monograph of the Genus *Gnathodon*, Gray (*Rangia*, Desmoulins)," and "New Tertiary Fossils from the Southern United States," appeared respectively in 1893, 1894, and 1895.

The Miocene fauna, referred to in the first of these papers, included six species of fossil shells, of which five were new and belonged to the following genera: Semele, Siphonaria Conus, Cerithium, and Diloma. They were assigned to a Miocene age. Faunally, the species point to a distinct analogy with those of the China and South Japan seas.

While Dall's work was in progress the Paleozoic and Mesozoic material collected by the museum from the southern and western United States was being studied by Charles A. White. The results of his work were published in the "Proceedings" from 1879–1894.

Heilprin's "Eocene Mollusca" appeared in 1880. It contains descriptions of species from southern United States, now in the National Museum.

In 1888 the publication of Walcott's brilliant series of papers on the Cambrian and pre-Cambrian fauna was begun, and continues up to the present. The first of the series contains descriptions of thirteen species and varieties, referred

by the author to nine genera, two of which, Karlia and Ogygopsis, are new. The latter genus is founded on *Ogygia klotsii*, Rominger. It differs from Ogygia in having a well-defined ocular ridge, and in the narrow palpebral lobe.

A second paper, issued in the same year, describes a fossil Lingula which preserves the cast of the peduncle. The specimen shows the interior of the anterior portion of the ventral valve of the *Lingula æqualis*, Hall, collected near Rome, New York, from the upper portion of the Lorraine Terrane. The portions of the shell remaining in the matrix show the median ridge extending back from the divaricator muscular scar, the reflex portion of the shell forming the false area and the groove for the passage of the peduncle. The portion of the peduncle preserved is nearly as long as the entire length of the shell.

The "Proceedings of the National Museum" for the following year (1889) contains descriptions by the same author of new invertebrate forms from the Trenton limestone, and from the Olenellus zone of North America. The material from the latter horizon consists of corals, trails, burrows, and tracks of animals, shells, and trilobites. Twenty-four new species were recognized, which were referred to twenty-two genera. Of the latter three were new, comprising one trilobite, Avalonia, and two shells, Coleoloides and Helenia.

New forms of Upper Cambrian fossils appeared in 1890, and the discovery of Oldhamia in America was published in 1894. The specimens referred to in the latter paper are preserved as casts on the surface of a smooth siliceous slate. They were found in great abundance in the gorge of the Poestenkill, near Troy, New York. The slates are post-Lower Cambrian and pre-Trenton, but their exact stratigraphic position is not fully determined. But one species is described. It is closely related to *Oldhamia antiqua* of the

Cambrian rocks of Ireland, but differs in some particulars, so that the author considers it a distinct species, and proposes for it the name *Oldhamia* (*Murchisonites*) *occidens*.

Another important work issued during this period is "The Genesis of the Arietidæ," contained in the twenty-sixth "Smithsonian Contributions to Knowledge," by Alpheus Hyatt. This memoir forms a quarto volume of over two hundred pages, including introduction, index, and explanation of plates. The general plan of the treatise is a discussion of the genealogy, genesis of characteristics, geologic and faunal relations, and, finally, descriptions of genera and species of Arietid Ammonitoidea.

The work sets forth the successional development of the different types of the ammonites of this division through the successive geologic ages, and is an important contribution to the general doctrine of evolution, since these forms illustrate the nature of direct evolution in definite directions, or orthogenesis, as it is called.

The illustrations consist of thirty-five figures in the text, six folding charts or tables, and fourteen plates, of which ten are heliotypes.

Simpson's papers on "Fossil Unionidæ" complete the list of invertebrate publications. These appeared in 1893 and in 1896, respectively. The first contains descriptions of Unios and other fresh-water shells from the Drift at Toronto, Canada, and a review of the distribution of the Unionidæ of northeastern North America. The second paper comprises diagnoses of some new Triassic Unios from the Staked Plains of Texas. The material on which this paper is based was obtained from the Dockum beds, an extensive Triassic fresh-water formation deposited in shallow water, underlying the Staked Plains of Texas. Four species are recognized. Taken as a whole, these Unios closely resemble in form, and are

apparently nearly related to those of the Jurassic beds of North America, while three of the species bring to mind most strongly the species which now inhabit Europe and western Asia, and a small group belonging to the Mississippi area. The variety of characters displayed by these Triassic Unios go to show that the genus must have been well established at the time the Dockum beds were laid down, thus tending to overthrow Neumayer's theory that the Unionidæ were derived from the genus Trigonia, which probably does not date back to a period earlier than that of the shells under consideration.

The first work published by the Institution in vertebrate paleontology was a memoir of the Mosasaurus and three new genera, Holcodus, Conosaurus, and Amphorosteus, by Robert W. Gibbes, and was issued in 1850.

The material upon which this memoir is based was found in the Cretaceous and Eocene marls of South Carolina and Alabama. The review of the literature of the subject is accompanied by two plates, showing the five species of Mosasaurus then known, and a third displaying the three new genera. This memoir was a quarto.

In 1852 Joseph Leidy's "Memoir on the Extinct Species of American Ox" was published, and was followed in 1853 by his celebrated report upon the Bad Land collections, entitled "Ancient Fauna of Nebraska." Both of these works belong to the "Contributions to Knowledge" series, and are handsomely illustrated.

In the first paper Doctor Leidy indicates the former existence of four species of ox, which were probably contemporaneous with the Mastodon and the Megalonyx. Fossil remains of these animals had been frequently found in the United States, and descriptions of them are scattered through various works; but no approach had before been made to a correct view

of the number and character of the species. Two of the species of ox described by Doctor Leidy belong to the genus Bison, and one of these is of gigantic size. The other two species belong to a new genus called Bootherium, which has been shown to be identical with Ovibos.

The material upon which the ancient fauna of Nebraska is based came from the drainage region of the Missouri, from the tract of country known by the name of "Mauvaises Terres," or the "Bad Lands." This at one time was the bottom of an immense lake, in which thousands of animals, having no representatives at this time on the surface of the earth, perished. The age of the beds is lower Miocene or Oligocene, and their special name in the closer divisions of formations is the White River Beds of Hayden.

This region having been brought to notice by a few fossil remains procured through the agents of the American Fur Company, an appropriation of about $200 for its exploration was made by the Smithsonian Institution to Mr. Thaddeus Culbertson, who was about to visit, on account of his health, the sources of the Missouri. The specimens of fossil remains which were thus procured, together with a collection subsequently presented to the Institution by Captain Stewart Van Vliet, of the United States army, and several specimens kindly lent by Doctor Prout, of Missouri, were referred to Doctor Leidy for examination. In addition to these he had the use of a collection lent by Professor O'Loghland, of Missouri, specimens belonging to the Academy of Natural Sciences, Philadelphia, and a collection made by Doctor Evans, at the instigation of Doctor D. Dale Owen, the whole embracing all the specimens which had yet been brought to the East from the Bad Lands. The bones were completely petrified, and their cavities filled with silicious matter. They were preserved in various degrees of integrity, some being beautifully perfect and others broken

and imperfect, the latter having been evidently subjected to violence while imbedded in a soft mud. Of hoofed animals, there were seven species of four genera, belonging to the Boöidea, or cud-chewing animals; two species of one genus belonging to the Suöidea, or hog-like animals; one species of the Solipedia, or solid-hoofed animals; and four species of three genera belonging to the Perissodactyla, or uneven-toed animals.

The first specimen described belonged to a peculiar genus of ruminants which, among recent animals, is more nearly allied to the musk-deer, and was hornless. The next is of a remarkable genus of ungulata, representing a type which occupies a position in the wide interval existing between recent ruminants and the anomalous fossil animal called the Anoplotherium. Another genus was called Oreodon, and constituted one of the links necessary to fill up the very wide gap between existing ruminants and an exceedingly aberrant form of the same family now extinct. There were also two remarkable species of rhinoceros, differing from any remains of this animal found in other parts of the globe.

Another fossil belonged to the feline family, about a fifth smaller than the American panther, and is probably the most ancient known genus of this animal. Hundreds of fossil turtles were found in the "Bad Lands," belonging to the genus Stylemys, of which five species are described. The memoir occupies one hundred and twenty-six pages, and is illustrated by twenty-four plates, one of which is a folio.

In 1855 a third memoir by Doctor Leidy, on "The Extinct Sloth Tribe of North America," was issued in the same series. This work forms an interesting addition to our knowledge of the extinct gigantic sloth tribe of North America. It comprises a description of remains of the genera Megalonyx, Mylodon, Megatherium, and of a new genus which he called Ereptodon.

The scientific world is indebted for the first account of the remains of a large extinct quadruped of the sloth tribe to President Jefferson. He described them in a memoir published in the "Transactions of the American Philosophical Society" in Philadelphia, in 1797, and gave to the animal to which they belonged the name of Megalonyx, or the great claw. The materials in his possession, however, were too scanty to allow of his determining the true character of the quadruped. Doctor Wistar, of Philadelphia, suspected the animal to have been a gigantic sloth; and this opinion was confirmed by Cuvier, from the ample materials for comparison at his command. The original bones described by Jefferson are preserved in the collection of the Philosophical Society; but, besides these, Doctor Leidy had access to specimens of the remains of the same animal found in different parts of the United States. From the study of all these he was enabled to throw much additional light upon the characters of Megalonyx. He considered that the only remains of this animal yet known were those found in the United States, and satisfactorily proved that the lower jaw of an extinct quadruped discovered by Charles Darwin in South America, and referred by naturalists to the Megalonyx of Jefferson, does not belong to an animal of the same genus.

The remains of the Mylodon, or gigantic sloth, were first discovered by Darwin in his researches in the southern part of South America. Remains of another species found in North America were described by Doctor Harlan, but were erroneously referred to the Megalonyx. Doctor Leidy, in his memoir, described the collection of the remains of this animal belonging to the New York Lyceum.

The Megatherium, which is the largest of all the extinct sloth tribe, when full grown, was more than fourteen feet long, including the tail, and eight feet high. It was first discovered

in South America, but has since been found in Georgia; and it was from this locality, the only one in the United States then known, that the remains described by Doctor Leidy were obtained.

The fourth and new genus of American sloths, called the Ereptodon by the author, was established upon a peculiar form of teeth which belonged to an animal of about the size of the Megalonyx, the bones of which were also found in the state of Georgia.

Doctor Hays, one of the commission to which this memoir was submitted, says in his report, that "the author has not only made valuable additions to our knowledge of an interesting tribe of animals, but has also collected and arranged the facts previously known so as to throw new light on the subject, and to render his memoir an important starting-point for future investigators."

A fourth memoir by Doctor Leidy was published in 1865. It consists of descriptions of remains of reptiles discovered in the Cretaceous formations of the United States, and, like the preceding ones, is one of the quarto series.

Multitudes of fossils are found in the American Cretaceous formations, though the species appear not to be so numerous as in those of Europe. The mollusks are particularly abundant, and among them are a great many species of chambered shells. A species of ammonite was found on the Upper Missouri as large as an ordinary fore-wheel of a wagon. Remains of fishes were likewise numerous, sometimes in excellent preservation and sometimes fragmentary. The teeth of sharks were especially numerous. Bones of reptiles were also abundant, and their remains form the subject of Doctor Leidy's valuable memoir.

Nothing further was published in vertebrate paleontology until 1883, when Edward D. Cope's memoir on "The Con-

tents of a Bone Cave in the Island of Anguilla" (West Indies) appeared in the quarto series. This memoir gives a description of the fossil vertebrates, shells, and also of the indications of human occupation discovered during the excavation of a cave in the West Indian island of Anguilla. The remains were discovered in 1868, and notices of them made, but the publication of a full account was delayed, in the hope that other objects might be added to the collection.

The importance of the subject is shown by the fact that it is the first investigation of the life of the cave age in the West Indies; that it gives the first reliable indication of the period of submergence, and hence of separation, of the West Indian islands, and that it describes some very peculiar forms of animal life not previously known.

The paper consists of thirty-four pages, and contains five plates, with one hundred and five figures, the illustrations being made particularly full on account of the archæological interest attaching to these animals, which were probably the contemporaries of the earliest men of tropical America.

A second work by Professor Cope was published in 1891 in the "Proceedings." This paper is a discussion of the "Characters of Some Paleozoic Fishes." It contains, in addition, descriptions of five new species and one new genus (Styptobasis) of fishes, and the cranial structure of Macropetalichthys is given for the first time. The author first referred this genus to the Placodermata (Arthrodira), in a review of Professor Newberry's work on "The Paleozoic Fishes of North America," in "The American Naturalist" for September, 1890, and the view has been adopted by A. Smith Woodward, and later authors.

In addition to the foregoing, the following reprinted papers from the annual Reports, and elsewhere, have been published as separates: Marcou's "Bibliographies of American Natu-

ralists" (1885); "Records of North American Paleontology," compiled for the years 1884, 1885, and 1886 by John B. Marcou, and for 1887–'88 by Henry S. Williams.

The first of these works forms the third volume of the "Bibliographies of American Naturalists," and is devoted entirely to a catalogue of the writings of those who have labored in the field of invertebrate paleontology, in connection with the researches and collections made by the Institution and the National Museum. The list of memoirs embraces: first, The published writings of Fielding B. Meek, numbering one hundred and five titles of papers (of which one was in conjunction with James Hall, seventeen in conjunction with F. V. Hayden, and twenty-five in conjunction with A. H. Worthen), and occupying one hundred pages; second, The published writings of Charles A. White, numbering one hundred and fifty-one papers (of which two were in conjunction with H. A. Nicholson and two in conjunction with O. H. St. John), and occupying sixty-six pages; third, The published writings of Charles D. Walcott, numbering twenty-seven papers and occupying fifteen pages; and fourth, A collection from fifteen authors of "Publications Based upon the Paleontological Collections of the United States Government," including the titles of three papers by Jacob W. Bailey, twelve papers by T. A. Conrad, five papers by James D. Dana, two papers by Christian G. Ehrenberg, seven papers by James Hall (one in conjunction with F. B. Meek, above referred to), two papers by Angelo Heilprin, three papers by Alpheus Hyatt, ten papers by Jules Marcou, two papers by John S. Newberry, one paper by I. N. Nicollet, four papers by David Dale Owen, and five by Owen and Shumard, two papers by Hiram A. Prout, one paper by James Schiel, seven papers by Benjamin F. Shumard, and five in conjunction with Owen (above referre[illegible] and lastly, five papers by Robert P.

Whitfield, these occupying seventy-two pages. An index of genera and species of invertebrate fossils occupies fifty-two pages. The work is supplied with a general index of subjects and authors, and forms an octavo volume of over three hundred pages.

In accordance with its policy, the Institution subscribed in 1857 for a few copies of a work on "The Pleiocene Fossils of South Carolina," by M. Tuomey and F. S. Holmes. This work received the commendation of some of the distinguished members of the American Association for the Advancement of Science, at its meeting in Charleston, in 1850, and its publication was undertaken at the risk and cost of the authors. To aid this enterprise, the Institution was induced to make the subscription above mentioned for copies to be distributed to foreign societies.

In 1856 the Institution considered favorably the proposition made by Doctor James Deane, of Greenfield, Massachusetts, to publish a memoir containing a series of illustrations of his researches relative to the celebrated fossil foot-prints in the sandstone of the Connecticut valley. The number of plates required to illustrate the memoir, as originally proposed, would have involved too great an expense to be met in one or even two years by the portion of the income of the Institution which could be appropriated to any single publication. It was, therefore, concluded that Doctor Deane should continue his investigations, and endeavor, by means of photography, to produce representations of all the most important specimens, and that from these a selection should be made sufficient to illustrate the characteristics of the different species of animals by which the impressions had been left. To assist in the experiments of photography and in lithographing the illustrations, a small appropriation was made, with which about fifty drawings were finished on stone by Doctor Deane before

his career was suddenly terminated by death. The work, however, was in such an unfinished condition that it could not be published.

During the years 1852–'56, inclusive, the Smithsonian Institution acquired a number of collections of fossils, partly as gifts, but chiefly through the diligence of its own collectors in the field.

In connection with the survey of Governor Stevens, Doctor Evans revisited the Mauvaises Terres in 1852, and collected a large number of specimens of the fossil vertebrata of that region. These were put into the hands of Doctor Leidy, who detected the presence of some additional new species. In 1853 Alexander Winchell sent quite a full series of the Cretaceous and Tertiary fossils of Alabama, and Major Emory the same of Texas. In 1854 an interesting series from the vicinity of Satow was forwarded by the Reverend L. Vortisch; G. Lambert, of Mons, presented a series of carboniferous fossils of Belgium; specimens from Texas were sent in by Lieutenant J. G. Benton, United States army, and by Doctor Julius Froebel; from Panama, by Doctor E. L. Berthoud; from Illinois, by Doctor R. P. Stevens; from North Carolina, by J. L. Bridger. A complete set of minerals and fossils of the remarkable Brown-coal beds of Brandon, Vermont, was received from David Buckland; sharks' teeth and mastodon bones of Florida, from Captain T. L. Casey, United States army; fossil-wood of California, from W. F. Langton, and infusorial earth of Monterey, from Major T. G. Barnard. The following year Doctor Hayden procured a number of fossil mammals from the Mauvaises Terres of White River and of the Blackfoot country, and a very valuable collection of minerals and fossils was received from the Lake Superior mining region. This collection was made by Foster and Whitney, to illustrate their government report,

and with other government geological collections, previously secured, furnished rich material for representing the geological features of the country. The Thomas Barnett set of Niagara fossils and minerals was also received in this year.

Various private collections were received in 1856, the principal ones being contributed by Doctor Ferdinand V. Hayden; I. Lippmann of Saxony; the Koenigliche Leopoldina Carolina Akademie of Breslau, Prussia, and the Natürforschende Gesellschaft of Emden, Hanover.

In 1868 and 1871 important accessions were made to the invertebrate department. William H. Dall sent part of the collection made by him in Alaska, the Aleutian Islands, and Eastern Siberia in 1865–'67, and other specialists contributed Permian material from Kansas and Lower Silurian fossils from Ohio. In 1875 the collections of fossil vertebrata from New Mexico, obtained by Edward D. Cope, Paleontologist of the United States Geographical Survey West of the 100th Meridian, were sent to the Museum. These collections form the basis of the report by Professor Cope contained in the fourth volume of the Reports of the above survey under Lieutenant George M. Wheeler, of the United States Engineers. The collections were from three horizons, and included one hundred and six species, of which eighty-one were new.

During 1878, 1879, and 1880, the following valuable donations were received: Black Hills fossils, from Professor Henry Newton; Californian fossils, from Senator Sargent; and the large collection of invertebrate fossils made by Lieutenant Wheeler, presented by B. H. Lyon and other paleontologists.

In 1884 the most important accession was that of Devonian and carboniferous fossils from the United States Geological Survey, many of them types of new species. Collections were also received of Mesozoic and Cenozoic fossils from California, Oregon, New Jersey, Florida, Alabama, and Mis-

sissippi, and fifteen miscellaneous lots were sent from private sources to the museum.

The F. W. Taylor collection, consisting of rare minerals and fossils from the vicinity of Lake Valley, New Mexico, was acquired in 1885, and the Jordan series of cretaceous fossils in 1889. During the latter year also C. D. Walcott collected and presented to the museum a large series of Lower Cambrian fossils from Conception Bay, Newfoundland.

A few selections from the collections of vertebrate fossils were made by the United States Geological Survey, under direction of O. C. Marsh, and placed in the United States National Museum in 1893. These included some specimens of Dinosauria of the Laramie formation of the family Agathaumidae; skulls of Menodontidae from the White River beds; skulls and bones from the Loup Fork beds of rhinoceroses of the genus Aphelops. When these collections are placed in the museum, the vertebrata of America will be as well represented as in any museum in the world.

In 1895 a valuable collection of remains of Zeuglodon was made by Charles Schuchert, and work on this material is now in progress.

BOTANY

By William Gilson Farlow

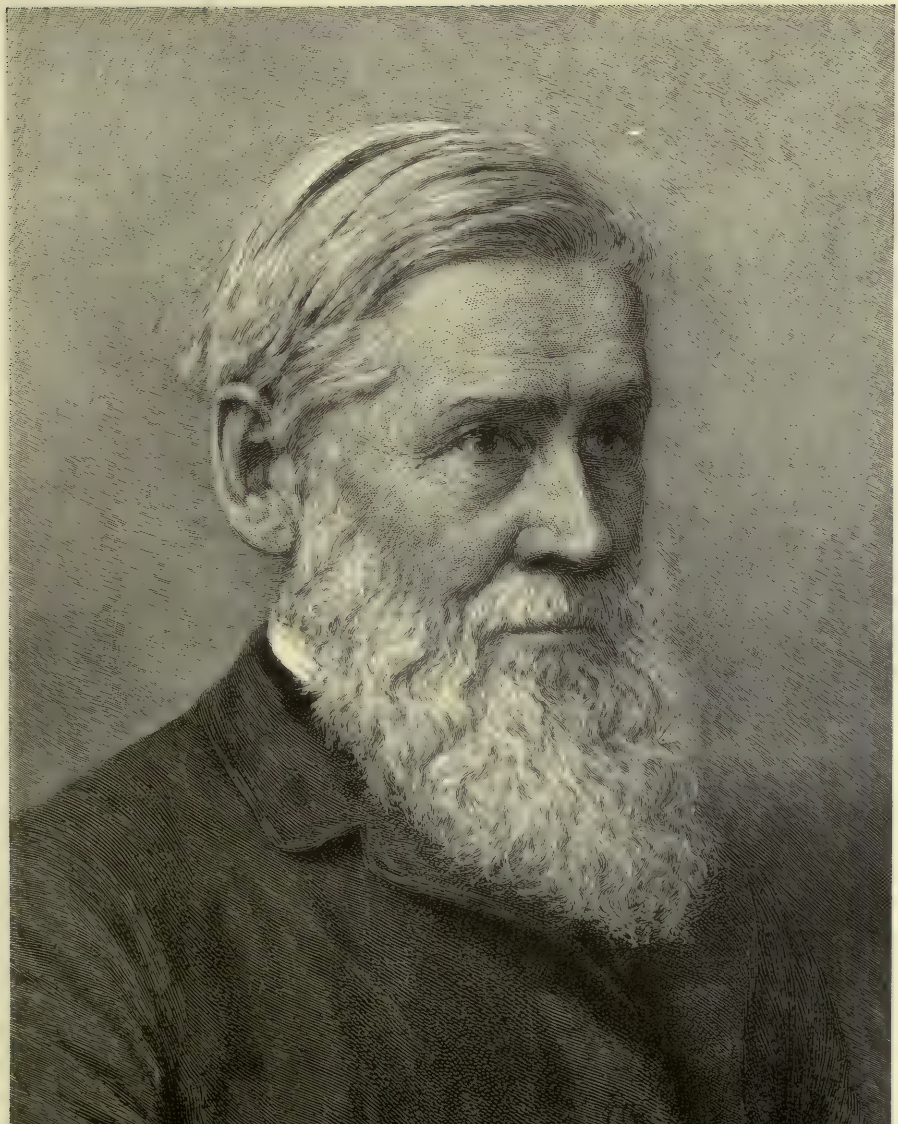
Professor of Cryptogamic Botany, Harvard University.

THE numerous and important services rendered to botanical science by the Institution may be considered under the following heads: First, the development of the knowledge of the phæno-gamic flora, especially of unexplored or little known regions of the South and West, through grants made to collectors in those regions, and more particularly by the publication in the "Contributions to Knowledge" and the miscellaneous publications of a series of important monographs on the North American flora by eminent American botanists; secondly, contributions to the knowledge of the algæ of the United States and of other low cryptogamous plants; thirdly, the diffusion of information in regard to the local flora of Washington and certain exotic floras, together with miscellaneous papers, either original or translated, on various botanical subjects printed in the different annual Reports or as Bulletins of the United States National Museum; and lastly, the formation of a National Herbarium.

The earliest reference to botanical work undertaken under

the direction of the Institution is to be found in 1848,[1] where mention is made of some drawings and engravings of a paper on the botany of Oregon, for which a small advance had been made, and in the same volume[2] it is said that a "report on the forest trees of North America," by Professor Asa Gray, is in progress. The paper on the botany of Oregon refers apparently to the work on the plants of the Wilkes expedition, of which the part by Gray appeared in 1854 and that by Torrey in 1873. The Report of 1849 again mentions the "report on the forest trees of North America," and says that "this work will be completed in three parts, in octavo, with an atlas of quarto plates,—the first part to be published next spring."[3] Numerous delays in the work are mentioned in the different Reports, and in that of 1856,[4] after referring to the pressing demands on the author's time and the difficulty of obtaining the necessary drawings from the artist, Isaac Sprague, it is said that "the work will be ready for the press during this year." Nothing more is heard of the projected flora beyond the statement in 1864 that work was to be resumed upon it by Professor Gray, until 1884, when its final abandonment by Gray was announced, and it was reported that, although a proposition which had previously been made by Professor C. S. Sargent to take up and complete the work had been accepted, its magnitude had proved too great for the funds at the disposal of the Institution, and that it had been arranged with Professor Sargent that he should refund the cost of the drawings which had been made by C. E. Faxon and receive them for publication with a private publisher. In 1891, the twenty-three beautifully colored plates which had been drawn by Mr. Sprague between 1849 and 1859 were issued by the Institution without text; and thus what was, as originally planned, to have been the first botan-

[1] "Smithsonian Report," 1848, page 16.
[2] *Ibidem*, page 19.
[3] *Ibidem*, 1849, page 18.
[4] *Ibidem*, 1856, page 32.



ical publication of the Institution, in reality formed its last quarto publication on a botanical subject.

In 1849 the Institution contributed $150 toward defraying the expenses of the botanist, Charles Wright, on an expedition to El Paso, Texas, and in 1852 appeared the first contribution to phænogamic knowledge, entitled "Plantæ Wrightianæ Texano-Neo-Mexicanæ," containing a description by Gray of the plants collected by Wright, together with many of those collected by Wislizenus in the valley of the Rio Grande and Chihuahua, and by Doctor Gregg in the same district and the northern part of Mexico. A second part of the "Plantæ Wrightianæ" appeared the following year, both parts with illustrations by Mr. Sprague. In rapid succession appeared three other "Contributions to Knowledge" by Professor John Torrey. It had been hoped that arrangements would be made by the government for publishing a general account of the botany of California, including the plants collected by Frémont on his different expeditions from 1842 to 1848, but there being no immediate prospect of such a work, Professor Torrey published in 1854, in the sixth volume of the "Contributions to Knowledge," a monograph entitled "Plantæ Frémontianæ," in which he gave an account of twelve of the most characteristic genera and species collected by Frémont in California, including the new genera Spraguea, Fremontia, Coleogyne, Emplectocladus, Carpenteria, and Sarcodes, the type of the latter being the then remarkable but now familiar snow-plant of the Sierras, *S. sanguinea*.

In the same volume are two other important papers by Torrey. In the first, "Observations on the Batis maritima of Linnæus," he gave the first full account of this anomalous species, which is widely diffused in the West Indies and South America, and placed it in a new order which he considered related to Empetraceæ. Although the genus was

afterward placed in Chenopodiaceæ by Grisebach in his "Flora of the British West Indian Islands" (1864), the genus was still kept as the type of a distinct order by Bentham and Hooker in their "Genera Plantarum," and also by Engler and Prantl in "Die Natürlichen Pflanzenfamilien," its natural position being near Amarantaceæ and Polygonaceæ.

In the second paper Torrey described the curious and characteristic pitcher-plant, *Darlingtonia Californica*, of which the first sterile specimens had been collected in California by W. D. Brackenridge, of the Wilkes Exploring Expedition. Flowering specimens were collected afterward by Doctor G. W. Hulse, and, with this material, Torrey was able to recognize the plant as the representative of a new gēnus of the curious order Sarraceniaceæ.

For many years the Institution had intended to publish for the use of those engaged in the study of Western plants a complete list, with synonyms, of all the species known in the region west of the Mississippi, and in 1870 Doctor Sereno Watson, who had acted as botanist of the Fortieth Parallel Expedition, was engaged to prepare such a work. The expense of preparation was to be borne by private subscription, the Institution paying for the clerical labor and for the publication. Work on the Index progressed until 1877, and one hundred and eighty-four pages had been stereotyped when Doctor Watson found his time much occupied with other work, and it was decided to publish the portion then finished, which included the orders of Polypetalæ, as Part I. This part appeared in 1878 under the title of "Bibliographical Index to North American Botany," as one of the "Smithsonian Miscellaneous Collections," forming an octavo volume of four hundred and eighty-four pages. The "Index" was very carefully and critically prepared, but, although of great service to working botanists, the character of the work was

so laborious that Doctor Watson did not feel able to continue it beyond the Polypetalæ.

The "Flora of North America," by Torrey and Gray, of which the first volume, including the Polypetalæ, appeared in 1838–'40, had never been continued beyond the second volume, including the Gamopetalæ, from Caprifoliaceæ through the Compositæ, issued in 1841–'43. At that point the publication was suspended, for so large an amount of new material had been brought together by the different government expeditions and by numerous private collectors, that it was decided by Professor Gray that, instead of completing the "Flora" in its original form, the orders already published should be entirely revised and, with the remaining orders, treated in a more condensed form, omitting the longer notes of the first edition, but retaining the essential part of the synonymy and reducing the descriptions to as few words as possible. The synoptical plan was adopted as being, all things considered, the briefest and best. Since the cost of printing such a synoptical flora was too great for private resources, and since the work offered no prospect of pecuniary profit to publishers, the Institution determined to aid the undertaking, and expended several thousand dollars in furthering this important botanical work, which probably cost its author nearly as much more. In consideration of this, Professor Gray was allowed to issue, for his own benefit, a first edition of five hundred copies of the work before the Institution attempted to publish its own edition. The order of publication was arranged so that the first part should include the Gamopetalæ after Compositæ, the subject treated being, therefore, a direct continuation of the original "Flora" of Torrey and Gray. This part, with the title of "Synoptical Flora of North America," Volume II, Part I, was issued by the author in May, 1878, and formed a volume of four hundred

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octavo pages. The next part to appear, including Caprifoliaceæ-Compositæ, being a revision of the second volume of the Torrey and Gray "Flora," was called Volume I, Part II, of the "Synoptical Flora," and was published by the Smithsonian Institution in July, 1884. In January, 1886, an additional part of about one hundred and fifty pages was published by the Institution, and contained supplements and indexes to the two parts previously issued. The death of Professor Gray occurred on January 30, 1888, and later in that year the two parts already published, together with the supplements, were bound together in one large volume and issued as one of the "Smithsonian Miscellaneous Collections." The further prosecution of the work was intrusted to Professor Gray's successor, Doctor Sereno Watson; but his death, a few years later, delayed the appearance of any part of the "Synoptical Flora" until, in October, 1895, Doctor B. L. Robinson, the successor of Doctor Watson as Curator of the Gray Herbarium of Harvard University, issued the first fascicle of Volume I, Part I, including Polypetalæ, from Ranunculaceæ to Frankeniaceæ, prepared, in part, from the manuscripts of Professor Gray and Doctor Watson.

The "Contributions" relating to cryptogams, which have been published by the Institution, treat mainly of algæ. The second volume of the "Contributions" included a paper by Professor J. W. Bailey on "Microscopical Examination of Soundings made by the United States Coast Survey off the Atlantic Coast of the United States," and another on "Microscopical Observations made in South Carolina, Georgia, and Florida." These were the first papers published by the Institution in which reference was made to plant-life. Since they did not treat exclusively of plants, but of animals as well, only passing notice is required in this connection. In these two papers, as well as in a later paper, "Notes on New Spe-

cies and Localities of Microscopical Organisms," contained in the third volume of the "Contributions," Professor Bailey included numerous lists of Desmids, Diatoms, and other small marine and fresh-water algæ, with descriptions, notes, and figures of the more interesting species and a few references to marine Florideæ.

We find in the Report for 1850,[1] the first reference to one of the most extensive and important botanical memoirs published by the Institution, namely, that of William H. Harvey, on the "Marine Algæ of the United States." Professor Harvey, of Trinity College, Dublin, distinguished for his extensive knowledge of marine plants, was invited in 1849 to give a course of lectures at the Lowell Institute in Boston, and, taking advantage of the presence of this expert algologist in our country, arrangements were made with him by the Institution for preparing a complete marine flora of our coast. In preparation for the work Professor Harvey spent several months on the Eastern coast, at Halifax, Massachusetts Bay, Long Island, Charleston, and Key West, studying the algæ and examining the herbaria of local collectors. On his return to Dublin he worked up the rich material he had brought together, and completed with his own hands the colored drawings to be used as illustrations. The expense of printing the text and plates being great, it was decided to issue the work in three parts. The first part, including the Melanospermæ, was published in 1852 in the third volume of the "Contributions," with one hundred and fifty pages and twelve plates. The second part, including the Rhodospermæ, appeared in the sixth volume the following year, but the third part, including the Chlorospermæ and supplement, did not appear until 1858. The three parts were then bound in one volume, entitled "Nereis Boreali-Americana; or, Contributions to a History

[1] "Smithsonian Report," 1850, page 12.

of the Marine Algæ of North America." The memoir of Professor Harvey forms the basis of our knowledge of the marine flora of North America, and, although the study of algæ has advanced very much, the "Nereis" is still a classic work, showing the skill of the author as a systematist.

In Harvey's "Nereis" there were included but a small number of fresh-water algæ. Professor H. C. Wood, Jr., who had published in 1869 a "Prodromus of a Study of North American Fresh-water Algæ"[1] completed a more elaborate memoir on the subject, which was accepted by the Institution and published in volume nineteen of the "Contributions," 1874, under the title "A Contribution to the History of the Fresh-water Algæ of North America." The classification adopted by Professor Wood was, in the main, that of Rabenhorst's "Flora Europæa Algarum Aquæ Dulcis et Submarinæ," in which the generic and specific limitations differed considerably from those of the present day; but the work of Professor Wood has special value from the large number of new and interesting species, particularly the two orders Nostochineæ and Œdogonieæ.

Probably no work published by the Institution awakened more interest in its day than the "Flora and Fauna within Living Animals," published in 1853 in the fifth volume of the "Contributions," by Professor Joseph Leidy. The subject was a novel one, and the vegetable parasites described by Leidy were exceedingly curious and quite perplexing. The species grow attached to the mucous membrane of the cavities in which they are found, and occasionally form the exterior covering of worms infesting the cavities. They were considered by Leidy to be algoid in character, and some of them, at least, appear to be related to certain genera formerly placed in Nostochineæ but now included in Schizomycetes.

[1] *Proceedings of the American Philosophical Society*, 1871, Volume XI, page 119.

The systematic position of the five new genera, Enterobryus, Eccrina, Arthromitus, Cladophytum, and Corynocladus, must be said to be still in doubt, for during the last forty years neither mycologists nor algologists have ventured to assign them definitely to their proper order, nor have they been able to add much to the account first given by Leidy.

Of the less elaborate botanical publications we may mention three papers on exotic floras: the "Flora of Alaska," published in the Report for 1867, by Doctor J. T. Rothrock, who gave an enumeration of the species, both of phænogams and cryptogams, collected by himself, as well as of those collected by previous explorers; the "Flora of St. Croix and the Virgin Islands," by Baron H. F. A. Eggers,[1] being an enumeration of phænogams and higher cryptogams of that region, with notes and introduction; and the "Botany of Bermuda," by General Sir John Henry Lefroy, formerly Governor of Bermuda,[2] a work similar in character to the preceding. A "Guide to the Flora of Washington and Vicinity,"[3] by Professor Lester F. Ward, was also a museum publication. An introduction, giving statistics and general character of the local flora, was followed by a list of one thousand three hundred and eighty-four species, excluding Thallophytes, together with a "Check-List" and "Descriptions for Collecting and Preserving Plants," which were issued separately the following year.

Scattered through the annual Reports of the Institution are several miscellaneous botanical papers which deserve notice. The Report of 1859 contains a paper by Doctor J. G. Cooper on the "Distribution of the Forests and Trees of North America," prepared in connection with some meteorological observations in progress under the direction of the In-

[1] "Bulletin No. 13 of the United States National Museum," 1879.
[2] "Bulletin No. 25 of the United States National Museum," 1884.
[3] "Bulletin No. 22 of the United States National Museum," 1881.

stitution. The Report for 1889 has a reprint of the address of W. T. Thiselton-Dyer, F. R. S., on "Botanical Biology," delivered at the meeting of the British Association in 1888, and in 1890 there is a translation of a paper by Professor M. Treub, "A Tropical Botanic Garden," giving an account of the Botanic Garden at Buitenzorg, Java, of which he was the director. The Report for 1891 contains a paper by Professor G. L. Goodale, "Some Possibilities of Economic Botany," an address delivered before the American Association in 1891, and a paper by James Rodway, "The Struggle for Life in the Forest," reprinted from the "Journal of the Royal Agricultural Society of British Guiana." We may also mention the account of "Progress in Botany" in various Reports: the accounts from 1879–'83 by William G. Farlow and those of 1887–'88 by Frank H. Knowlton.

The first step taken by the Institution toward the formation of a national herbarium was the arrangement made with Charles Wright, mentioned in the Report for 1849, to which we have previously referred. In consideration of the $150 subscribed toward defraying the expenses of Mr. Wright on his botanical trip to El Paso, the Institution was to be entitled to a full set of all the plants he collected. At about the same date, a set of the plants collected by Fendler in 1847 in the vicinity of Santa Fé was purchased, and it was proposed, further, to assist him by the purchase of a set of the collections he might make in the future. The policy of the Institution in regard to giving aid to collectors and receiving in return sets of the plants collected was expressed in the Report for 1849 in the following words: "By coöperating in this way with individuals and institutions, we are enabled, at a small expense, materially to advance the cause of science."[1] The Report for 1851, referring again to the sets of Wright

[1] "Smithsonian Report," 1849, page 6.

and Fendler, states that these sets, together with plants collected by Lindheimer, "form the nucleus of an important and authentic North American herbarium."[1] The Reports for 1853 and 1856 refer to several additions to the herbarium — mainly phænogams from Oregon, Alabama, and other localities, a small collection from the Dead Sea, and fungi from South Carolina collected by Ravenel. Other additions were from time to time reported, the most important being a set of Doctor Berlandier's Texas plants, in 1855, and the unique set of ferns collected by Brackenridge on the Wilkes Exploring Expedition in 1862.

Previous to 1868 the policy of the Institution with regard to botanical collections had been to purchase sets of different collectors, to encourage private donations of plants, and to act as custodian of the sets of plants collected on the different government expeditions. In 1868, however, the herbarium contained from 15,000 to 20,000 specimens from different parts of the world, and it became necessary to adopt a more definite policy with regard to the large and rapidly increasing collection. Up to this date the Institution had depended mainly upon Professor Torrey and Professor Gray for the general arrangement of its collection, but as the time at the disposal of those botanists was limited, it became evident that the constant superintendence of a competent botanist was indispensable. The funds of the Smithsonian Institution were, however, far too meager to enable it, together with its other important duties, to undertake the proper care of the herbarium. Since the Agricultural Department required such a collection for continual reference, and had, in fact, begun to form a collection; and, furthermore, since it required the services of a practical botanist in the course of its investigations, it seemed advisable to unite the two collections. The

[1] "Smithsonian Report," 1851, page 11.

considerations of the transfer are given as follows, in the Report of 1868: "The transfer is made with the understanding that the superintending botanist shall be approved by the Institution, that the collection shall be accessible to the public for practical or educational purposes, and to the Institution for scientific investigation or for supplying any information that may be asked for by its correspondents in regard to the names and character of plants. It is further stipulated that due credit shall be given to the Institution in the publications of the department for the deposit of the original specimens, as well as for the additions which, from time to time, may be made to them by the Institution."[1] In return for this transfer, the Agricultural Department agreed to turn over to the Institution any specimens relating to ethnology or to other branches of natural history than botany then in its possession or which might thereafter come into its possession. The transfer of the herbarium to the Agricultural Department was referred to again in the Report[2] for 1870, where an account was given of the most important collections contained in the herbarium at the time of the transfer in 1868 and those subsequently received.

If we consider in its entirety the botanical work accomplished by the Institution during the first fifty years of its existence we find that it gives a picture of the gradual progress of botany in a new, and to a great extent unexplored, country. The first botanical problem to be solved in a new country is of necessity the exploration of its different parts and the description of the native species. As the systematic knowledge of the native flora increases, the important question as to the causes of the distribution of the different species, the effects of soil, temperature, and other climatic and biological conditions, assume a greater and greater significance, and when a general

1 "Smithsonian Report," 1868, page 15. 2 *Ibidem*, 1870, page 36.

knowledge of the flora has become widely diffused throughout a country, the stage is reached where the more general and abstract problems belonging to the domain of vegetable physiology and the minute investigations in cytology and the study of life-histories attract the attention of the rising generation of botanists. In the early years of the Institution the main object of botanists was to find out what plants grew in North America. Fortunately, among the native botanists were such well-trained men as Torrey, Gray, Engelmann, Bailey, and Wood, upon whom the Institution could call to assist in the working up of a great share of our native plants. In branches in which there were no competent American experts the Institution did not hesitate to secure the services of foreign botanists, as in the case of the "Nereis" of Harvey.

The most important service rendered by the Institution to botanical science has been the very liberal aid furnished to specialists by enabling them to publish the various monographs which appeared in the "Contributions to Knowledge" and in the "Miscellaneous Collections." No comment on the great value of this series of publications is needed, for the mere enumeration of the works to which we have already referred is, to any one at all familiar with the history of botanical literature, a sufficient indication of the debt we owe to the Institution. In the scientific presentation of the subjects treated, in the admirable illustrations, and in the liberality with which the memoirs have been distributed to public institutions and private botanists throughout the world, the Institution has well merited the praise which it has received at home and abroad. Nor, in recognizing that the first desideratum was an accurate account of our native species, did the Institution fail to encourage, as far as possible, the study of climatic and other causes which affect the distribution of plants, for certain of the botanical papers we have mentioned were prepared as collat-

eral aids to work done in meteorology and other branches of science. If among the botanical contributions we find none on physiological or histological subjects, it should be said that the development of botany in this country has been slower than that of zoölogy, and it is not until quite recently that the study of botany with us has been expanded so as to embrace all branches of the science. The period we are now considering was that in which descriptive botany prevailed. Circumstances are now favorable to a widening of the field in this direction in the future.

The foresight of the Institution in collecting and preserving the different collections of plants which were to form a nucleus for a national herbarium is greatly to be commended. Acting as a faithful custodian of this material, so valuable for future study, until a date when circumstances indicated that it could be intrusted with safety to other hands, and leave the limited funds at its disposal to be spent on the care of collections in other departments of science, the herbarium was transferred, on conditions which were liberal, but also conservative, for the Institution still has a voice in the selection of the botanist appointed to take charge of the collections. It is to be regretted that the efforts of the Institution in 1855 to induce Congress to establish an arboretum on its grounds did not meet with a favorable response from that body.

ZOÖLOGY

By Theodore Gill

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ACCEPTING the terms of the fundamental organization of the Smithsonian Institution, the consideration of its relations to the progress of zoölogy might be expected from two points of view: first, the "increase of knowledge" as the result of original investigation, and second, the "diffusion of knowledge among men" by publication. It will, however, become obvious on reflection that the relation of the Institution to the increase of knowledge must be chiefly through the stimulus of means which it may furnish to the original investigator. The actual increase of zoölogical knowledge has been effected through the investigations of those connected with the Institution directly or indirectly, and as the result of studies of the collections amassed in the museum. The increase of knowledge effected by the Institution is therefore to be found in the aggregate of individual discoveries resulting from the study of material collected through its agency, or first made known in its publications. The most natural course, then, will be to review the furtherance by the Institution of exploration for zoölogical material,

the building up of a museum, and the publications which it has stimulated or provided for in various ways. This review will be a simple narrative of facts in which no criticism or commendation will be indulged in.

EXPLORATIONS

ONE of the most efficient means by which the Institution has advanced zoölogical science has been through the respect which its chiefs have enjoyed from the heads of government departments, and the consequent readiness with which the government authorities have carried out suggestions for investigations in connection with various operations.

The general government had early recognized the advisability of exploration of the wild territory acquired from time to time, and numerous surveying expeditions had been despatched for that purpose. The first of special importance was the famous expedition of Lewis and Clarke "performed during the years 1804–'06," and the narrative of which has been published in many editions, culminating in the luxurious one recently edited by Doctor Elliott Coues. This expedition was the precursor of many others. Attempts were made in connection with some of them to further our knowledge of the fauna and flora of the countries traversed; but, with one exception, zeal was unaccompanied by knowledge, and the results were negative. (The exception was Major Long's "Expedition from Pittsburg to the Rocky Mountains, performed in the years 1819–'20," to which the first great American zoölogist, Thomas Say, was attached as naturalist.) But after the Smithsonian Institution had been housed and fully organized, favoring conditions for scientific direction supervened. No important surveying party was then despatched without a naturalist nominated or approved by the Institu-

tion. Chief of such expeditions were the "Explorations and Survey of the Valley of the Great Salt Lake of Utah" (1852), by Captain Stansbury; the "Expedition down the Zuñi and Colorado Rivers" (1851), under Captain Sitgreaves; the "Exploration of the Red River of Louisiana" (1852), by Captains Marcy and McClellan; and the "United States and Mexico Boundary Survey" (1857–'59), superintended by Major Emory. The collections made by the peripatetic naturalists were deposited in the museum of the Institution, and the vertebrates and some of the invertebrates were reported upon by Baird, Girard, and others.

But by far the most important of the collections and the reports were the results of surveys for a Pacific railroad long desired and at length undertaken.

In March, 1853, provision was made by Congress for "explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean," to be made under the direction of the Secretary of War. Under this Act, in 1853 and 1854 several parties, commanded by officers of the corps of topographical engineers of the United States army, were sent out to examine different routes suggested or proposed for a railroad. Through the influence of the Institution, naturalists or collectors were attached to the various parties, and the collections made by them of the vertebrates at least were "worked up" soon after their reception by the Institution.

The collections were mostly studied within the walls of the Smithsonian building; and the reports were published at length in the great official work (extending to thirteen large quarto volumes) devoted to the details of all the operations connected with the surveys. But these detached reports had been to some extent anticipated by preliminary accounts of the results given to the world in many articles contributed

to the "Proceedings of the Academy of Natural Sciences of Philadelphia," and other periodicals. The species and genera new to science were very numerous; and the faunal characteristics of regions little or not at all known before were revealed in considerable detail.

Scarcely any long stretch of coast in the entire world was so little known, from a zoölogical standpoint, as was that extending from Alaska to Mexico. Especially true was this for ichthyology. A number of the fishes of northern and Russian America had been described by Tilesius, Pallas, and Richardson; but only about a dozen species had been authenticated from the great stretch of coast just mentioned. A few species had been described in 1836 by Sir John Richardson, a single one (*Chimæra colliei*) in 1839 by Lay and Bennett, and another (*Syngnathus californiensis*) in 1845 by Storer. The literature otherwise was confined to brief and insufficient indications, too unreliable or too meager for positive identification. In 1853 and 1854, Louis Agassiz introduced to public notice, with much éclat, the remarkable viviparous perch-like fishes inhabiting the California coast, which he called Holconoti or Embiotocoidæ. These papers and others by Gibbons slightly anticipated the publication of the results of the explorations for the Pacific route. But in 1854 and following years, Charles Girard contributed descriptions of the many new genera and species of fishes obtained by the United States expeditions, and in 1859 a final report embracing all the forms known from the Pacific coast of the United States was issued. One hundred and forty-eight nominal species of salt-water fishes were described, and most of them illustrated; and a fair idea was thus given of the piscine fauna of that previously neglected coast. This monograph of Girard's was included in the tenth volume of the Pacific Railroad Reports.

Still more important in some respects, although less replete with startling novelties, were two volumes emanating from the pen of Spencer F. Baird, then Assistant Secretary of the Institution. Many new species of mammals and birds had been collected by the naturalists of the Pacific Railroad surveys, and the identification and correct classification of the material obtained necessitated comparisons and consequent studies of most of the species of the entire continent. To such an extent was this the case that Baird deemed it expedient to extend his researches to cover *all* the North American material described or contained in the Institution. The result was the preparation and publication of two massive quarto volumes comprising all that was known systematically of the mammals and birds of America north of Mexico. These volumes formed the eighth and ninth of the Pacific Railroad Reports.

Extra sheets of the text of both of these volumes on mammals and birds were subsequently published in connection with the plates already issued (often retouched and considerably altered) and some new ones. Copies of the plates published in connection with the reports of the United States and Mexican Boundary Survey were also incorporated.

The United States and Mexican Boundary Survey had been organized for the delimitation of the boundary between the United States and Mexico under the conditions provided for in the treaty of 1853. Major W. H. Emory was the United States commissioner, and the field work of the commission was performed in 1854 (December) and 1855. The naturalists of the survey were John H. Clark and Arthur Schott. The mammals, birds, and reptiles were reported on by Professor Baird, and the fishes by Doctor Girard. The text in this report was less noteworthy than the plates: the latter were numerous, and many of them very well executed,

and among these were the ones subsequently modified to appear in the privately published volumes on the mammals and birds. A like work was intended for the reptiles, and forty-four plates appeared in the United States Pacific Railroad Report, and forty-one in the United States and Mexican Boundary Report, but the increasing duties devolved on Professor Baird prevented its accomplishment.

The expeditions thus referred to have been specifically mentioned because they were the first provided for in accordance with a new policy, and through them the general peculiarities of the countries traversed were first made known. Innumerable minor expeditions were subsequently sent out, but few were accompanied by naturalists or reported upon by experts connected with the Institution. A noteworthy volume was Simpson's "Report of Explorations Across the Great Basin of the Territory of Utah in 1859," but not published till 1876. The various geological surveys may also be referred to in this connection.

After the civil war four independent geological surveys were organized within a short time of each other, and became for a time contemporaneous. These were (1) the "United States Geological Survey of the Territories," initiated in 1867 through the efforts of Ferdinand V. Hayden; (2) the "Geological Exploration of the Fortieth Parallel," under the leadership of Clarence King (also legislated into existence in 1867); (3) the second division of the "United States Geological and Geographical Survey of the Territories," organized by John W. Powell in 1870; and (4) the "United States Geographical Survey West of the One Hundredth Meridian," conducted by George M. Wheeler of the United States Engineers, established in 1871. The heads of all these organizations interested themselves more or less with zoölogical investigations, and coöperated with the

Smithsonian Institution in the collection of specimens, and also published reports or memoirs on representatives of the existing fauna. Eventually, however, all were superseded by a new United States Geological Survey created by a law approved March 3, 1879.

MUSEUM

When the Smithsonian Institution finally became established it began to occupy a place that had been previously vacant. In Washington there was practically no museum. The nucleus of one was existent in the collections obtained by the United States Exploring Expedition during the years 1838 to 1842, under Commodore Wilkes, but that at first was under no competent supervision. Excellent collections had been made by the naturalists attached to that expedition, and representatives of several classes had been placed in the hands of well-known specialists. The mammals and birds were referred to Titian R. Peale and John Cassin, the reptiles and amphibians to Spencer F. Baird and Charles Girard, the fishes to Louis Agassiz, the classes of mollusks to Augustus A. Gould, and the crustaceans and zoöphytes to James D. Dana. All of these, except Professor Agassiz, made elaborate reports on the specimens intrusted to them, and the collections, which were returned, thus became a very considerable and more than ordinarily valuable basis for a museum, inasmuch as a very large proportion of the species collected and described were new, and thus types. The American naturalists anticipated in many cases the results of the contemporaneous British expeditions.

But although special provision was made, in the law providing for the establishment of the Smithsonian Institution, for the transfer to the new institution of all of what may be

called museum material, the law was not made operative till many years afterward. Meanwhile, the collections made by the Wilkes Exploring Expedition and some minor accumulations remained in the Patent Office building under no scientific supervision, and suffering from lack of care and want of appreciation of their value. Tradition relates that an occasional friendly visitor interested in conchology might even be allowed to carry off desiderata for the increase of his own collection. Little regard, too, was had for the labels or tickets which had been applied by the describers to the specimens returned. In other ways the collections deteriorated. It was not till 1856 that the Institution took advantage of its right to secure what remained.

The original museum administered by the Smithsonian Institution had grown up from humble beginnings and in spite of adverse conditions. Its nucleus was a collection of vertebrates of Pennsylvania and some other regions of the neighboring States which Professor Baird had made in his student days and while he served as a professor of natural sciences in Dickinson College. This collection consisted chiefly of skins of birds and mammals, as well as reptiles and amphibians preserved in alcoholic spirits, and skeletons or skulls of mammals, some of birds, and a few of reptiles, amphibians, and fishes. These were by small accessions gradually added to by Professor Baird himself, and by many amateur collectors.

In the ninth annual report it was even claimed that "a *museum*, the most complete of any in existence in several branches of the natural history of the North American continent, has been collected, which has been valued at $30,000." [1] But the then chief of the Institution (Professor Henry) did not view with favor the employment of the funds of the

[1] "Smithsonian Report," 1854, page 9.

establishment for a general museum. In the fourth annual Report he recalled that, "by the law incorporating this Institution, 'all objects of art and of foreign and curious research, and all objects of natural history, plants, and geological and mineralogical specimens belonging to or hereafter to belong to the United States, which may be in the city of Washington, in whosesoever custody the same may be, shall be delivered to such persons as may be authorized by the Board of Regents to receive them.'"[1] Nevertheless, the Secretary was loath to take advantage of this law, although, in his own words, it "evidently gives to the Smithsonian Institution the museum in the Patent Office, the conservatory of plants, and all specimens of nature and art to be found in the several offices and departments of the government."[1] It was agreed that "the act, however, cannot be construed as rendering it obligatory on the Regents to take charge of these articles."[1] It was considered that even "an annual appropriation for the support of the museum of the exploring expedition" would be "objectionable, since it would annually bring the Institution before Congress as a supplicant for governmental patronage";[1] for the Secretary was "fully convinced that the true policy of the Institution is to ask nothing from Congress except the safe-keeping of its funds."[2] The regents therefore "declined to accept this museum as a gift," but "a few years"[3] later they reconsidered their determination. It was found that "the cost of keeping the museum of the Exploring Expedition" then in the Patent Office was "about $5000" a year, and for that sum the Institution expressed a willingness to take charge of the natural history collections in question.

In the Report for 1858 the Secretary announced that

[1] "Smithsonian Report," 1849, page 20. [2] *Ibidem*, page 21.
[3] *Ibidem*, 1856, page 22.

"this proposition was agreed to by the government, and the contemplated transfer has accordingly been made."[1] But an annual appropriation of only $4000 was made, and this was continued for many years.

The appropriation by the government in 1858 of $4000 a year marks an epoch in the history of the Smithsonian Institution as well as of the National Museum. By the Act so passed the sustentation of a special museum was to that extent recognized, and thus the National Museum may be considered to have been originated by the Act of appropriation. It was indeed on a very small and inadequate scale, but the beginning was made of a national museum.

Up to this time the collection had been almost exclusively devoted to vertebrates, and "the following table exhibits the additions made to the record books of the museum in 1857, in continuation of previous years:"[2]

	1851	1852	1853	1854	1855	1856	1857
Mammals	None	114	198	351	1200	2046	3200
Birds	. .	. .	. .	4353	4425	5855	8766
Skeletons and skulls . . .	911	1074	1190	1275	2050	3060	3340
Reptiles	. .	. .	. .	. .	. .	106	239
Fishes	. .	. .	. .	. .	. .	155	613

Although the collections of the Exploring Expedition had become much deteriorated and suffered considerably from spoliation under incompetent custodians, it was still a rich one, and many types of the numerous new species described by Dana, Gould, Peale, Cassin, and Girard remained. The invertebrates of the sea at last began to be in evidence, and quite a respectable nucleus of a general zoölogical museum became existent.

The subsequent increase was quite rapid, and resulted from many government expeditions, but was mostly confined to

[1] "Smithsonian Report," 1858, page 14. [2] *Ibidem*, 1857, page 49.

the acquisition of American material and to what was acquired by donation.

In the Report for 1867 it was recalled that "when the government museum was transferred to the Institution, it was stipulated that an appropriation should be annually made for it,"[1] and that "the appropriation for this purpose had been limited until the last session of Congress to the sum of $4000."[2] It was then announced that "the appropriation was, last year, temporarily increased to $10,000, but," it was added, "even were this continued, it would be still quite inadequate to the suitable maintenance of a national museum."

During all these years there were no paid curators for the zoölogical part of the museum, and reliance was had only on volunteer aid of persons too busily engaged in other pursuits properly to take care of collections of which they were nominal curators. The difficulties of such curators were much enhanced, too, by frequent changes and removals of collections from place to place without supervision. The collections even suffered also by the very willingness to make them useful; for example, in 1867 Doctor William Stimpson was authorized to take most of the collection of American invertebrates, especially crustaceans and east-coast mollusks, to the Chicago Academy of Science, of which he was director, for purposes of study. He had engaged to prepare manuals of the marine mollusks and crustaceans of the eastern United States, and had prepared many descriptions and illustrations of mollusks and shells, when the disastrous fire of 1873 destroyed a large portion of the city of Chicago, and with it the building of the Academy in which the collections had been housed. The loss was irretrievable. The long labors of years were obliterated, and the life of the author, unsupported by hope or anticipation, and prostrate by grief, soon succumbed.

[1] "Smithsonian Report," 1867, page 55. [2] *Ibidem*, page 56.

It was not till 1876 that systematic provision was made for curators for the museum. The history from that period has been given in the chapter on the United States National Museum, to which reference may be made for the history of its subsequent development.

PUBLICATIONS

INSTRUCTIONS FOR COLLECTORS AND ADJUNCTS

An important service has been rendered by the Institution in inducing naturalists of eminence to prepare manuals or guides for the determination of species belonging to various classes or other groups of the animal kingdom.

The activity of many naturalists, ever increasing, not only in the United States but elsewhere, had largely added to the numbers of known species of many classes of animals, but the literature was very scattered and to many students quite inaccessible. The labor devolved upon the person who would identify a species had become most onerous, and even after long search it would often be doubtful whether he had exhausted the sources of information. Thus, on the one hand the Charybdis of imperfect knowledge and slovenly work threatened, and on the other the Scylla of forced inactivity. The time had come when the scattered information should be collected and an abundant literature systematically indexed. The Secretary of the Institution received with favor propositions to compile guides for the identification of the species of various groups of animals.

As early as 1851 Doctor Charles Girard had published "A Monograph of the Cottoids" as the first and only published part of "Contributions to the Natural History of the Fresh-water Fishes of North America." This was so well done that regret must be entertained that it was not followed by others

in like style. In 1853 Professor Baird and Doctor Girard published a descriptive work on the "Serpents" of the country as the first part of a "Catalogue of North American Reptiles"; but this also was the last as well as the first of its kind. The continuous work began later, and the publications, under various guises, were essentially of two kinds — lists of species and descriptive monographs. But first efforts were made to obtain the requisite material, and circular letters asking for specimens, and often accompanied by special instructions for collecting were sent out broadcast. Entomologists were appealed to and instructed in numerous circulars and pamphlets; the earliest of which were published in the annual Report of the Institution for 1858.

These were followed in subsequent years by many others relating to insects, mollusks, fishes, reptiles, birds, and bird's eggs, mammals, and skeletons.

Intimate relations had been established between the Smithsonian Institution and officers of the Hudson Bay Company, through the friendly agency of Robert Kennicott, who had been for some time a sojourner in the company's territory, and had inspired a spirit of collecting and observation. A special "Circular to the Officers of the Hudson Bay Company" was therefore published in 1860, indicating desiderata and containing instructions for collecting as well as for meteorological observations.

In 1867, when the United States acquired from Russia the territory subsequently named Alaska, but then generally known simply as Russian America, another pamphlet was prepared for an expedition sent to the territory by the Treasury Department. This pamphlet was entitled, "Suggestions Relative to Objects of Scientific Investigation in Russian America" (1867), and covered very largely the same field as the preceding circular.

The Institution contributed to the needs of its correspondents and collectors in another way. Under the title of "Smithsonian Museum Miscellanea," in 1862, it published sheets giving the abbreviated names of states, territories, etc., often repeated, and intended especially for insect-collectors, and also five sets of numbers of different sizes. These were frequently called for.

Here, perhaps, is also the most apt place to mention a work of much more general importance than any of the publications hitherto mentioned, but which belongs to the category of adjuncts to the collector's and describer's outfit. The work in question was compiled as well as published at the expense of the Smithsonian Institution, and was entitled, "Nomenclator Zoologicus: an alphabetical list of all generic names that have been employed by naturalists for recent and fossil animals from the earliest times to the close of the year 1879." The author was Doctor Samuel H. Scudder, and the completed work was published in 1882.

It is a rule observed by almost all naturalists not knowingly to give or adopt a name, already used for one genus, to or for another. But the difficulty of finding out whether a given name had already been used would be very great under ordinary circumstances, and the task of doing so would entail a disproportionate expenditure of time. With the advancing years and increasing number of investigators and describers, the uncertainty and labor involved would be greatly increased. In order to meet the demand for ready reference, from time to time nomenclators or indexes to the genera proposed have been published. The first important one was prepared under the direction of Professor Louis Agassiz, over half a century ago (1842–'46), and another, by Count von Marschall, was published about a quarter of a century later (1873). But useful as both were, another was

demanded. The names had increased manyfold since Agassiz's work appeared, and Von Marschall's work was not only old, but much time had to be wasted on account of its division into twenty-one separate lists. The work of Scudder, in which all the names were arranged in a single alphabetical list, was therefore a most welcome boon to naturalists. Instead of the twenty thousand (19,966) names of Agassiz's time, about eighty thousand were given in the new work, and the last "Nomenclator Zoologicus" became an indispensable adjunct to the laboratory of every systematic zoölogist. Even this has now become superannuated, and a new edition, or rather new work, is already being prepared under the auspices of the Institution, and may be expected before the close of the century.

The earliest of the bibliographical aids published by the Institution was by Charles Girard, and entitled, "Bibliographia Americana Historico-Naturalis; or, Bibliography of American Natural History for the year 1851" (1852).

Other aids furnished by the Institution for the benefit of investigators are the bibliographies published from time to time. Some of these form a special series entitled "Bibliographies of American Naturalists," and five have been published, namely:

I. "The Published Writings of Spencer F. Baird, 1843–1882" (1883).

II. "The Published Writings of Isaac Lea" (1885).

III. "Bibliography of Publications relating to the Collection of Fossil Invertebrates in the United States National Museum, including Complete Lists of the Writings of Fielding B. Meek, Charles A. White, and Charles D. Walcott" (1885).

IV. "The Published Writings of George Newbold Lawrence" (1891); and

V. "The Published Writings of Doctor Charles Girard" (1891).

Another collateral to the series just considered, but nevertheless an independent volume, relates to an English naturalist long very active in the study of American birds. It is "The Published Writings of Philip Lutley Sclater, 1844–1896" (1896).

The Institution for a number of years also published in its annual Reports, and again as separately paged pamphlets, records of the progress of zoölogy and paleontology during previous years.

The reports on zoölogy, seven in number, were by Theodore Gill, and covered the years 1879 to 1886.

The reports on the progress of paleontology were four in number, namely: those for the years 1884, 1885, and 1886, by John B. Marcou; and that for the year 1887, by Henry S. Williams.

A party for the observation of the transit of Venus in 1874 was sent by the government of the United States to Kerguelen Island, and Doctor Jerome H. Kidder, Assistant Surgeon of the Navy, served as naturalist. He published "Contributions to the Natural History" of the island visited, in two parts (1875 and 1876); one embracing a general view of the animals as well as plants, and the other containing an account of the birds by Doctors Coues and Kidder.

Another biological memoir by a naval medical officer was the result of Doctor Thomas H. Street's collections and observations, and was published in the form of a bulletin of the National Museum.[1]

"Contributions to the Natural History of Arctic America,

[1] "Contributions to the Natural History of the Hawaiian and Fanning Islands and Lower California, made in connection with the United States North Pacific Surveying Expedition, 1873–'75," octavo, 172 pages, Washington (1877).

made in connection with the Howgate Polar Expedition" in 1877–78 (1879), were by Ludwig Kumlein.

A contribution to zoögeography was a memoir "On the Zoölogical Position of Texas," by Professor Edward D. Cope, which was published in 1880.

The visits to the island of Bermuda, whose fishes were catalogued in 1876 by Doctor Goode, further fructified in 1884 in "Contributions to the Natural History of the Bermudas," edited by the same gentleman, and including articles by seven other contributors on the various classes of animals, as well as in botany and geology.

The Institution took an active part in various exhibitions, and prepared catalogues of considerable general value as guides for forming as well as for viewing the collections. The most important of these, all of which were prepared by Doctor G. Brown Goode are: "Classification of the Collection to Illustrate the Animal Resources of the United States. A List of Substances derived from the Animal Kingdom, with Synopsis of the Useful and Injurious Animals, and a Classification of Methods of Capture and Utilization" (1876); "Catalogue of the Collections to Illustrate the Animal Resources and the Fisheries of the United States, exhibited at Philadelphia, in 1876, by the Smithsonian Institution and the United States Fish Commission, and forming a part of the United States National Museum" (1879); "Exhibition of the Fisheries and Fish Culture of the United States of America at the Internationale Fischerei-Ausstellung held at Berlin, April 20, 1880, and forming a part of the Collections of the National Museum, made by the United States Fish Commission" (1880); and "Descriptive Catalogues of the Collections sent from the United States to the International Fisheries Exhibition, London, 1883, constituting a Report upon the American Section" (1884).

In 1878 the United States National Museum began the publication of its "Proceedings," and in the annual volumes of that series numerous articles were published describing new species, and often containing important discussions of the affinities and relationship, and sometimes synoptical monographs of various groups.

Although published under the general direction of the Smithsonian Institution, the record of these belongs rather to the history of the National Museum than to that of the Smithsonian Institution, and therefore no further reference need be made to them in this connection.

INVERTEBRATES

THE marine invertebrates, with the exception of the mollusks, had been much neglected by American naturalists, the only authority who had contributed much respecting any of them during the first half-century having been Thomas Say. In 1853 a "Synopsis of the Marine Invertebrates of Grand Manan, or the Region about the Mouth of the Bay of Fundy, New Brunswick," was published in the sixth volume of the "Smithsonian Contributions to Knowledge." This memoir has become a classic, and has made the locality whose fauna is recorded in it famous as a collecting-ground. It was the first complete view of the invertebrate animals of any American territory that had been published in the United States, and many now well-known species were for the first time recorded in it.

"A Fauna and Flora within Living Animals" is the title of one of the "Smithsonian Contributions" (published in the fifth volume) embodying the results of observations by Doctor Joseph Leidy of the *Julus marginatus* (the *Spirobolus marginatus* of recent naturalists) and the *Passalus cornutus.*

The former is a common myriapod or milleped; the latter a large coleopterous insect or beetle found abundantly in decaying wood, and whose fat white grub is often met with. In the milleped no less than seven species of lowly entozoans, and in the beetle two, were found, described, and figured. In the cockroach six species had been found, of which two were for the first time made known. Several other new species of entozoans from other insects were also described.

COELENTERATES

THE only memoir on any Coelenterata published by the Institution outside of the "Proceedings of the National Museum" was one on the "Lucernariæ and their allies," by Henry James Clark, and was in the twenty-third volume of the "Smithsonian Contributions to Knowledge."

CRUSTACEANS

THE Crustacea have received especial attention from the Smithsonian Institution, and are well represented in the United States National Museum; much has also been published by the officers in charge of the collection in the "Proceedings of the United States National Museum." But with the exception of the two unimportant articles giving instructions for coöperation and asking for information respecting crawfish, no independent publication on the class has been issued by the Institution.

INSECTS

THE insects have been treated of in a number of volumes, in which various orders or other groups were systematically dealt with.

The first publication was one of the "Smithsonian Contributions to Knowledge," and appeared in 1850. It was on "The Classification of Insects from Embryological Data," by Louis Agassiz.

The Coleoptera were generally studied in the early days of the Institution, as they still are. A "Catalogue of the described Coleoptera of the United States" (1853), by F. E. Melsheimer, led the way. Long afterward it was succeeded by instalments of a "Classification of the Coleoptera of North America," by Doctor John L. Le Conte (Part 1, 1862; part 2, 1873), and a "List of the Coleoptera of North America" (1866), by the same naturalist. It was not until 1883 that Doctor Le Conte, with the coöperation of Doctor G. H. Horn, completed the "Classification of the Coleoptera of North America."

"New Species of North American Coleoptera" were also described by Le Conte in two instalments, the first of which was published in 1863, and the second in 1873.

A "Contribution to Knowledge" of the faunal regions and geographical distribution was published by Le Conte under the title of "The Coleoptera of Kansas and Eastern New Mexico" (1859).

The Lepidoptera form another order which received special attention from the Smithsonian Institution.

A "Catalogue of the described Lepidoptera of North America" (1860) was not long afterward followed by a "Synopsis of the described Lepidoptera of North America" (1862); both of these were compiled by the Reverend Doctor John Morris. The first part of the Synopsis, including the diurnal and crepuscular Lepidoptera, was the only one published.

The labors of the student who would seek to know what has been published respecting the early stages of Lepidop-

tera have been much lightened by a "Bibliographical Catalogue of the described Transformations of North American Lepidoptera," by Henry E. Edwards (1889).

An important subdivision of nocturnal Lepidoptera has been considered in two publications by Professor John B. Smith. One is a "Contribution toward a Monograph of the Insects of the Lepidopterous Family Noctuidæ of Temperate North America," in the form of a "Revision of the Species of the Genus Agrotis" (1890); the other is "A Catalogue, Bibliographical and Synoptical, of the Species of Moths of the Lepidopterous Superfamily Noctuidæ found in Boreal America, with Critical Notes" (1893). Both of these were published as bulletins of the National Museum.

The Neuroptera were enumerated in a "Synopsis of the Neuroptera of North America," by Doctor Hermann Hagen, published in 1861.

The Orthoptera were also listed, Doctor Samuel H. Scudder having prepared a "Catalogue of the Orthoptera of North America described previous to 1867," which was published in 1868.

As early as 1860 a special "Circular in Reference to the History of North America Grasshoppers" was sent to many correspondents of the Institution; but the specimens and information obtained in response were not directly utilized for a special work on that group.

The Hymenoptera of the family Vespidæ were partly monographed by Henri de Saussure of Geneva, Switzerland, in a "Synopsis of American Wasps"; but only the portion treating of the tribes Masarinæ (Parasitic Wasps) and Odynerinæ (Solitary Wasps) was published (1875). Another important hymenopterous family was described in "A Monograph of the North American Proctotrypidæ" (1893), by William H. Ashmead.

The Diptera also early received attention. A provisional "Catalogue of the described Diptera of North America," by Baron Robert Osten-Sacken (1858), was replaced twenty years later (1878) by an enlarged and critical catalogue bearing the same title.

A series of "Monographs of the Diptera of North America" was next provided for, and edited by Baron Osten-Sacken. Four of these were published, of which the first, second, and third were by Doctor H. Loew of Meseritz, Prussia, and the fourth by Baron Osten-Sacken. The first (1862) gives a sketch of the systematic arrangement of the Diptera, and monographs of the North American Trypetidæ, Sciomyxidæ, Ephydrinidæ, and Cecidomyidæ (the last by the editor); the second (1864) is confined to the family Dolichopodidæ; the third (1873) treats of the family Ortalidæ; and the fourth (1869), of the North American Tipulidæ. Long afterward, in 1886, a monograph or "Synopsis of the North American Syrphidæ," also an important family, by Professor Samuel W. Williston, was published as a bulletin of the United States National Museum.

Another series of lists of species, with references to one or more of the descriptions of each of the species, was also published. Several orders of insects were thus catalogued, the Diptera by Baron R. Osten-Sacken (1858 and 1878), the Lepidoptera by Doctor John G. Morris (1860), and the Orthoptera by Doctor Samuel H. Scudder (1868).

MYRIAPODS

The so-called Myriapoda form a heterogeneous though generally recognized group which has been much neglected till recent years. A young student, Charles H. Bollman, who had been trained under the auspices of Doctor David S.

Jordan, undertook the study of the species, and displayed marked zeal and ability, publishing a number of papers before his early death in his twenty-first year. These papers were combined in a bulletin of the United States National Museum, entitled "The Myriapoda of North America, by Charles Harvey Bollman, edited by Lucien M. Underwood" (1893). They have had much influence on the present trend of method and treatment of the group in question.

MOLLUSKS

Enumerations with mere names of species of several classes were early published; such were the "Check-lists of the Shells of North America," by Isaac Lea, Philip P. Carpenter, William Stimpson, William G. Binney, and Temple Prime. These lists were sometimes of families, as the "Unionidæ," by Lea, and the "Cyclades," by Prime; sometimes of a class, or a large part of a class, as the "Terrestrial Gasteropoda" and the "Fluviatile Gasteropoda," both by Binney; and sometimes of faunal regions, as the "West coast" (separated into the "Oregonian and Californian province" and the "Mexican and Panamic province"), by Carpenter, and the "East coast," by Stimpson.

Various groups of shells were described and illustrated in different ways under the general title, "Land and Fresh-water Shells of North America," of which four parts were issued between 1865 and 1875.

"Part I," including the land shells, or "Pulmonata geophila," was the result of a joint authorship by W. G. Binney and T. Bland, and was not published till 1869. At a much later period what may be considered as a new edition of the work on land shells was published, and quite properly appeared under a new title, as will be hereafter seen. "Part

II," including fresh-water and marine Pulmonata, or "Pulmonata Limnophila and Thalassophila," as well as "Part III," embracing the Pectinibranchiate and Rhipidoglossate gastropods ("Ampullariidæ, Valvatidæ, Viviparidæ, fresh-water Rissoidæ, Cyclophoridæ, Truncatellidæ, fresh-water Neritidæ, Helicinidæ"), appeared as early as 1865; and both were prepared by William Binney alone. It may be added that proof-sheets of both those parts were quite widely sent out in book form to specialists; and the investigations and criticisms to which they were subjected entailed works differing very widely in their final form from the proof examples circulated, and thus rendered evident the wisdom of the course of seeking further information before final publication. "Part IV" was devoted to the "Strepomatidæ (American Melanians)," and was not published till 1875. Its author was George W. Tryon.

In the four parts of the "Land and Fresh-water Shells of North America" thus published, all the species found in the United States and the Dominion of Canada were described and illustrated. The Gastropoda were the only forms included, and these were for the first time embraced in a continuous series.

The species of the class known at the time of publication of the several volumes were apportioned to various groups. Part I included the pulmonate land shells; part II the pulmonate aquatic shells; and parts III and IV the gilled aquatic and land shells.

Part I.	Pulmonata Geophila		286
	" Limnophila . . .	127	
Part II.	" Thalassophila . .	4	
	" (Siphonariidæ) . .		131
Part III.	Pectinibranchiata	57	
	Rhipidoglossata	11	
			68
Part IV.	Pleuroceridæ		444

The census thus taken revealed no less than eight hundred and twenty-nine nominal species of gastropods inhabiting the United States. The aggregate of the species known at the present day is not very much greater, and the figure is too large for at least one family — that of the "Pleuroceridæ," or American Melanians.

The bivalves could not be treated in the same manner as the gastropods. There are only three families represented in the United States, but one of them — the Unionidæ — is an immense assemblage of species, and no one could be found willing to undertake the task of monographing them. The other families — Cyrenidæ and Pisidiidæ — were then universally combined in one, and in 1865 were treated by Temple Prime in a "Monograph of the American Corbiculadæ (recent and fossil)." In this monograph one hundred and eleven species were recognized, of which ninety-three belong to the family Cyrenidæ and eighteen to the family Pisidiidæ. In these numbers, however, are embraced not only the recent species of temperate and cold North America, but also those of the warm regions and South America, as well as the extinct species. Reduced within the limits covered by the other monographs, the numbers were as follows:

Cyrenidæ	32	Pisidiidæ	12

A small monograph, evoked by the differences of opinion respecting questions considered in the "proof" of the third part of the "Land and Fresh-water Shells of North America," was published meanwhile (in 1865) by Doctor William Stimpson, and embraced the results of anatomical studies, especially of the lingual ribbon, of the Hydrobiids.

In 1885 Mr. Binney resumed a consideration of the terrestrial Pulmonates in "A Manual of the American Land Shells." This is the volume already alluded to in connection

with "Part I" of the "American Land and Fresh-water Shells." Most of the descriptions, synonymy, and illustrations of that volume are reproduced in the "Manual," but the classification is modified, and instead of the matter being in a continuous systematic sequence, it is broken up and arranged under seven geographical categories — species "*a.* Universally distributed," "*b.* Pacific province," "*c.* Central province," "*d.*" "*e.*" and "*f.*" "Eastern province," "Northern region," "Interior region," and "Southern region," and "*g.* "Locally introduced."

In addition to the foundation for future studies laid in the several monographs here described, further aid to bibliographical studies was given by the publication in 1863 and 1864 of a "Bibliography of North American Conchology." The extent of this work may be judged by the fact that the two parts cover nearly one thousand pages.

The other articles and memoirs of various kinds based more or less on the material collected by the Institution are numerous, but have appeared in other publications.

FISHES

As early as 1851 "Contributions to the Natural History of the Fresh-water Fishes of North America" were initiated by Doctor Charles Girard in "A Monograph of the Cottoids." This monograph was an excellent article, and the entire anatomy was described and illustrated in detail. Unfortunately, "Part I" was also the last of the "Contributions," and no other separate publication on fishes appeared for many years. "A Report on the Fishes of the New Jersey coast, as observed in the summer of 1854, at Beesley's Point," by Professor S. F. Baird, was indeed published in the ninth annual Report of the Smithsonian Institution, and also issued

separately, with an independent title-page and index, but did not receive a serial number till many years later. Meanwhile "Memoranda of Inquiry" and "Questions relative to the Food Fishes of the United States" were circulated to procure information. To serve as a basis for future work, an "Arrangement of the Families of Fishes," a "Catalogue of the Fishes of the East Coast of North America," and a "Bibliography of the Fishes of the Pacific Coast of the United States" were prepared by Theodore Gill.

To the same or a like category belong a "Classification of the Collection to Illustrate the Animal Resources of the United States" (1876), and "Descriptive Catalogues of the Collections sent from the United States to the International Fisheries Exhibition, London, 1883, by Doctor Goode."

With the field thus surveyed and mapped, articles soon appeared describing various groups or faunas.

The first published was a "Catalogue of the Fishes of the Bermudas" (1876), by Goode, in which the nomenclature was well considered and many useful data were given.

Next appeared several parts of "Contributions to North American Ichthyology, based primarily on the Collections of the United States National Museum," by Doctor David S. Jordan, in which various families of fresh-water fishes were elucidated and collateral questions inquired into. As a result of all previous studies, a "Synopsis of the Fishes of North America" was given by Doctors David S. Jordan and Charles H. Gilbert, bringing the information gathered through many years and scattered in numerous volumes well up to date. Quite full descriptions of the species as well as including groups were given: 1340 species were recognized and distributed under 487 genera, 130 families, 23 orders, and 4 classes. The contrast between this work and one bearing the same title by Doctor D. H.

Storer, published in 1846, was a notable one, and a comparison between the two will give some idea of the progress of the science between the two periods. A new edition of this "Synopsis," or rather a new work bearing the title, "The Fishes of North and Middle America," by Doctor Jordan and Doctor B. W. Evermann, appeared later, the first volume having been published in 1896. With the increase of region covered, a great increase of species is naturally involved. The last work covers essentially the same ground as Storer's "Synopsis" of 1846, both including the fishes of the continent down to the Isthmus of Panama, as well as those of the West Indian Islands.

The work of 1846 embraced notices of 729 nominal species, representing 218 genera and 35 families. The work of 1896, as appears from the authors' "check-list," will embrace, when completed, descriptions of more than 3100 species, representing 1053 genera and 228 families. Even more notable than the numerical acquisitions are the mode of treatment and the aptness of diagnoses.

Last in time, but in some respects the most important of the ichthyological contributions, was a work published as a special bulletin of the United States National Museum. It is also noteworthy as the last complete work emanating from Doctor George Brown Goode, and appeared within a month of his death. Doctor Tarleton H. Bean was his collaborator in this as in many previous memoirs. The new work was on "Oceanic Ichthyology, a treatise on the deep-sea and pelagic fishes of the world, based chiefly upon the collections made by the steamers *Blake*, *Albatross*, and *Fish Hawk* in the northwestern Atlantic, with an Atlas containing 417 figures." As a summary of knowledge respecting the forms under consideration, the work is an epochal one, and the numerous species contrast remarkably with the few known

not longer ago than two decades. "Only twenty years ago," the authors write, "the fish fauna of the deep sea was represented in collections by forty or fifty specimens, representing not more than twenty species at the most — accidental waifs picked up at the surface or cast ashore by the waves."

A work whose place is rather in archæology than ichthyology may be referred to because of its interest to ichthyologists. It is on "Prehistoric Fishing in Europe and North America" (1884), by Charles Rau, and was published as one of the "Smithsonian Contributions to Knowledge."

AMPHIBIANS

As EARLY as 1853, a monograph on the "Anatomy of the Nervous System" of the common bullfrog of the United States, called, in conformity with the accepted nomenclature of the day, *Rana pipiens*, but now known as *Rana catesbiana*, was supplied by Doctor Jeffries Wyman to the "Smithsonian Contributions to Knowledge." It was a creditable and well illustrated memoir.

In 1875, Professor Edward D. Cope enumerated the recent species of amphibians in his "Check-list of North American Batrachia and Reptilia." In 1883, another "Checklist of North American Reptilia and Batrachia" was prepared by Doctor Henry C. Yarrow.

Finally, all the materials in the National Museum, as well as the literature, were considered and discussed in a descriptive and thoroughly illustrated volume entitled "The Batrachia of North America," by Professor Cope. In the "letter of transmittal" it is stated that descriptions are given of fifty-three Urodela and forty-seven Salientia, thus aggregating just one hundred species.

Some remarkable species have been added to the North

American fauna since the publication of Professor Cope's monograph. The most notable are two blind forms described by Doctor Leonhard Stejneger, one in 1892, a cave salamander (*Typhlotriton spelæus*) of the family Desmognathidæ, and the other in 1896, a tenant of subterranean waters, and related to the Proteidæ (Typhlomolge).

REPTILES

THE earliest contributions to herpetology published by the Smithsonian Institution were also contributions to paleontology. The first was a "Memoir on Mosasaurus, and three Allied New Genera," by Doctor Robert W. Gibbes, and appeared in 1850. A second by Doctor Joseph Leidy, including the tortoises from the "Mauvaises Terres," of Nebraska, was published in 1853. A third was a monograph of the "Cretaceous Reptiles of the United States" (1865), and was also from the pen of Leidy.

In the year 1853, the first part of a "Catalogue of North American Reptiles in the Museum of the Smithsonian Institution," by Spencer F. Baird and Charles Girard, was published, and embraced diagnoses and detailed descriptions of all the "Serpents" found in America north of Mexico. New principles of classification were introduced in this work, and on the whole the species were more naturally grouped than in any previously published work and many unknown species were added to the fauna. Indeed, the chief fault charged upon the work was an undue multiplication of species; but although amenable to the criticism, the fault has been exaggerated and the authors have been found to be often more nearly right than their early critics. Check-lists of all the reptiles were published later. One by Cope appeared in 1875 and another by Yarrow in 1883.

The numerous memoirs on various species and groups of reptiles, for which the museum of the Institution furnished the material in whole or part, were published chiefly in the "Proceedings of the Academy of Natural Sciences of Philadelphia," and the "Proceedings of the United States National Museum." The other separate publications, involving the reptiles, were on their anatomy and physiology: one by Doctor S. Weir Mitchell made known "Researches upon the Venom of the Rattlesnake" (1860); another, by Doctors Mitchell and George R. Morehouse, described "Researches upon the Anatomy and Physiology of Respiration in the Chelonia" (1863). A quarter-century after the publication of the researches on the rattlesnake, the senior author (Doctor Mitchell), seconded by another (Doctor Edward T. Reichert), published the results of later "Researches upon the Venom of Poisonous Serpents" generally (1886).

BIRDS

THE earliest of the "Contributions to Knowledge" relating to ornithology was the beginning of a "North American Oölogy," by Doctor Thomas M. Brewer. A "first part," descriptive of the "Raptores and Fissirostres," was published in 1857, but was never succeeded by another. In 1895 this field was covered by a new work entitled "Life Histories of North American Birds," illustrated by many plates, in which the eggs are delineated. The new work was by Major Charles Bendire, and was extended to two volumes, but this must also remain unfinished on account of the death of the author. The work of Bendire is noteworthy as opening a new series in quarto form, published under the auspices of the Institution and designated "Special Bulletin," the volumes in question being the first and third "Special Bulletins."

The several catalogues of North American birds issued by the Institution — and especially the octavo edition of 1859 — were long in great demand among bird and egg collectors for cataloguing purposes. In 1881, however, they were replaced by a new catalogue by Robert Ridgway, entitled "Nomenclature of North American Birds," and this in turn served the purpose of most collectors until it was supplanted by the "check-list" published by the American Ornithologist Union in 1886.

Professor Baird did not abandon his ornithological studies after the publication of his great work on North American Birds, but extended them to the species of Middle and South America, and went over the ground he had already so well surveyed. In 1863 the Institution issued a circular relative to collections of birds from Middle and South America, and a "List of the Described Birds of Mexico, Central America, and the West Indies, not in the Collection of the Smithsonian Institution," and solicited desiderata. With the new material thus obtained, Baird began in 1864 the publication of "Part I" of a "Review of American Birds in the Museum of the Smithsonian Institution," including those of North and Middle America, and continued the issue in instalments till 1866, when increasing duties compelled him to abandon it after having covered a number (fourteen of the system adopted) of the families of Oscines.

In 1866 a separate issue of an "Outline of a Systematic Review of the Class of Birds," by W. Lilljeborg, and an "Arrangement of Families of Birds," containing only the names of those divisions and including groups, by Spencer F. Baird, were issued.

These general works on American ornithology were supplemented by a number of special memoirs on various avifaunas as follows: One such was a catalogue of the

"Birds of Southwestern Mexico, collected by Francis E. Sumichrast," was prepared by George N. Lawrence in 1875, and an Avifauna Columbiana, being a list of birds ascertained to inhabit the District of Columbia, by Elliott Coues and D. Webster Prentiss, was published in 1883. Another was a catalogue of "The Birds of Bermuda," by Saville G. Reid in 1884, and "Results of Ornithological Explorations in the Commander Islands and Kamtschatka," by Leonhard Stejneger, appeared in 1885.

Among the "Contributions to Knowledge" is a "Classification and Synopsis of the Trochilidæ," by Daniel G. Elliott, which was issued in 1879, and at the same time also appeared an independent "List of Described Species of Humming Birds," by the same author.

MAMMALS

The earliest memoirs on the mammals published by the Smithsonian Institution related to fossil forms, and were issued as "Contributions to Knowledge." Three such contributions were furnished by Doctor Joseph Leidy. The first was a "Memoir on the Extinct Species of the American Ox" (1852); the second was included in "The Ancient Fauna of Nebraska" (1853); and the third was "A Memoir on the Extinct Sloth Tribe of North America" (1855). These were all well illustrated.

A "Catalogue of North American Mammals," by Spencer F. Baird, published in 1857, is merely an edition of the table of contents of his work on North American mammals. An analogous catalogue was published in 1884 as "A Provisional List of the Mammals of North and Central America and the West Indian Islands," by Frederick W. True.

No work on an extensive order was for a long time pub-

lished, except a "Monograph of the Bats of North America," by Doctor Harrison Allen (1864). Many years afterward (1895) a new edition of this monograph by Doctor Allen was published as a "Bulletin of the United States National Museum" (1893).

In 1889 "A Review of the Family Delphinidæ," by Frederick W. True, was also issued as a Bulletin of the United States National Museum."

The first part of an "Arrangement of the Families of Mammals" (1872) was published by Theodore Gill, but the completion of the work was prevented by the poverty of the collections in foreign material.

Several physiological memoirs were also issued by the Institution, as follows: "On Strain and Overaction of the Heart," by Doctor J. M. Da Costa (1874), the "Dual Action of the Brain," by Doctor C. E. Brown-Sequard (1874), and "The Effect of Irritation of a Polarized Nerve" (1880), by B. F. Lautenbach.

ANTHROPOLOGY

By Jesse Walter Fewkes

Editor of the Journal of American Ethnology and Archæology

THE influences on the many branches of the science of anthropology which have sprung from the Smithsonian Institution, during the last half-century, have been far-reaching and profound. In this prolific epoch the science has grown almost from infancy to manhood, from an humble beginning to ever increasing conscious strength, and there is no American institution which has so profoundly influenced the development of the study of man.

Two aspects of this influence claim our attention, and it is noteworthy that they are both directly related to those for which the Smithsonian Institution stands — the advancement of knowledge and its diffusion among men. An indication of the potency of the former is seen in the long series of original researches made possible by the accumulation of collections and systematic field explorations fostered by the Institution. The publication of these researches has enlarged knowledge, stimulated scientific investigation in other intellectual centers, and drawn to the museum scholars from all parts of the world. Judged from the point of view of scholarship,

the Smithsonian Institution from its foundation, fifty years ago, has been to the American anthropologist a foster parent of original research.

This is, however, but one aspect of the influences which this Institution has exerted on the study of man. A rich and well-arranged collection of anthropological material not only attracts the scholar, forming the basis of the researches of the specialist, but also is a great educational factor to the community at large. A well-arranged museum is an unwritten encyclopedia, teaching many who are not reached by other methods. The wealth of anthropological objects spread before the visitor to the museum exerts a profound influence on the intelligence of the community. Thousands visit a collection, and inspect its anthropological treasures, who never open a scientific book. The mind is, indeed, dull that is not in some way affected by simply strolling through the museum, and hundreds of visitors have had an interest excited in anthropology from such a visit. This method of diffusion of knowledge is no less a function of a museum than research and publication, and in point of fact it touches the multitude, while technical science appeals to the few. From what has been written it may be evident that a treatment of the influences of the Smithsonian Institution on anthropology, past and present, falls under two headings,— research and publication; collections and their installation. The former appeals especially to the student, and commonly measures the standing of an institution among scholars; the latter concerns the general public, and determines its value as an educational institution among the many. While I shall emphasize the former, since it more readily submits to analysis, the greatness of my subject admits no such limitation. The silent lessons daily taught by ocular demonstrations we have no scale to measure, no statistics to tabulate

save number of visitors; the museum teaches a lesson to each visitor and exerts an influence which eludes analysis.

ARCHÆOLOGY

The publications in this department of anthropology which have emanated from the Smithsonian Institution are many and comprehensive. As the large majority relate particularly to the antiquities of North and Central America, they may be considered under the following headings:

1. Appalachian Mountains and Atlantic Slope.
2. Rocky Mountains and Pacific Slope.
3. Central Region.
4. Mexico and Central America.
5. West Indies.

APPALACHIAN MOUNTAINS AND ATLANTIC SLOPE

The prehistoric denizens of this region have received much attention, and researches and publications on its archæology have been numerous and important.

The evidences of paleolithic man in the valley of the Potomac and the Trenton gravels have been critically examined and ably discussed by assistants in the Institution; and the works of Abbott, Rau, Holmes, and Wilson have attracted wide attention among students of this subject.

Professor Baird early recognized the great field for research presented by the kitchen middens of the Atlantic Coast, and personally carried on studies of these prehistoric camping places on the coast of Maine. Doctor Rau discussed in 1872 a gold ornament from a Florida mound, and six years earlier called attention to the artificial shell deposits on the coast of New Jersey.

ROCKY MOUNTAINS AND PACIFIC SLOPE

By an interesting coincidence, in the same year that the Smithsonian was founded, there was added to the territory of the United States an immense domain in the Southwest, rich in most interesting antiquities of a prehistoric race of unique characters. Early explorers of this vast region brought back fascinating accounts of ruins of a kind novel to men of Anglo-Saxon blood—the cliff-houses and so-called pueblos. The influence of the Institution can readily be traced in the aims of several exploring expeditions, which, one after another, enlarged our knowledge of this new archæological realm. Active work in this prolific field began with the foundation of the Bureau of American Ethnology in 1879, an account of which would naturally fall in another chapter. The most important publication on the architecture of the ancient pueblos of Cibola and Tusayan, as likewise the most complete on the antiquities of the pueblo area which has yet appeared, is to be found in one of the "Reports of the Bureau of American Ethnology," a work of great industry, both in office and field, by Victor Mindeleff. The expeditions of James Stevenson brought enormous collections of ethnological material from this region, enriching the museum with many archæological objects of great value.

Valuable archæological work has been carried on under the auspices of the Smithsonian Institution on the Santa Barbara Islands, off the coast of southern California, and in the caves of the Aleutian Islands, the character of which in the latter locality can best be considered elsewhere.

The Alaska Commercial Company in 1875 presented to the Institution a series of mummies from the Aleutian Islands and Prince William's Sound. W. H. Dall prepared a memoir

on this collection, with an account of related tradition, history, and other material such as he had obtained in eight years' experience in the region of the globe in which they were found. His memoir, which is well illustrated, was an important contribution to a little known subject.

CENTRAL REGION

THE most striking of the many archæological problems of the central region are those connected with the mound builders, the antiquities of the Mississippi valley and those of the Saint Lawrence. The influence of the Smithsonian Institution has always been wisely directed to fostering and advancing the investigation of these mounds of the United States, and its publications are recognized, both at home and abroad, as most important contributions to this subject. Previously to 1847 the unaided pioneer work of Caleb Atwater and others had called attention to these antiquities, but without awakening a widespread interest in the subject. To no one institution does archæological science owe so much as to the Smithsonian in quickening dormant interest in the study of the mound builders, and there is probably no department of anthropology where the publications of the Institution have done more to arouse interest in research than in this. The "Smithsonian Contributions to Knowledge" open with a most valuable article on the "Ancient Monuments of the Mississippi Valley," by E. G. Squier and E. H. Davis, a classic work illustrated by forty-eight lithographic plates and two hundred and seven woodcuts. This volume, which appeared in 1848, was followed two years later by another written by the senior author on a related subject: "Aboriginal Monuments of the State of New York." These memoirs, especially the former, may be regarded as epoch-

making, a worthy introduction to a subject which dates an ever-growing interest from that year. If we may judge from results, the fifty years during which "Squier and Davis" have been familiar words with American and foreign archæologists, whenever the mound builders are referred to, has well justified the following quotation from a letter of Honorable George P. Marsh of equal age: "It is fortunate," he says, "for the cause of American archæology that the first systematic attempt at its elucidation — (referring to the problem of the mound builders) — should have been conceived and executed in so truly philosophical a spirit; and rich as this age already is in antiquarian lore, it has, I think, received few more important contributions. . . . The Smithsonian collections could not begin with a more appropriate or creditable essay." These two works were followed by a supplementary communication by Charles Whittlesey and a memoir by I. A. Lapham, both of great value. Lapham described figure mounds from Wisconsin, representing a variety of fanciful forms of animals which had been overlooked by previous travelers. The figures represented men, bears, foxes, birds, reptiles; the style of mound seemed to have been limited to the plains of the upper Mississippi river. But the memoir is not confined in its treatment to these forms; it includes likewise tumuli, embankments, and like structures.

This memoir presented the subject with accuracy and skill, and had an important influence on the growing interest in the antiquities of the west. Lapham's researches were carried on under the direction of the Antiquarian Society of Worcester, Massachusetts, by which his memoir was presented to the Smithsonian Institution for publication, a good example of the harmony with which the Institution has always worked with societies of kindred aims.

Mr. S. F. Haven, the librarian of the American Antiqua-

rian Society of Worcester, prepared, by special request of the Institution, a memoir which formed a part of the seventh volume of the "Contributions." This was a thorough and able article with a bibliographical character, summarizing the opinions of early writers on American antiquities, and the existing knowledge of aboriginal monuments east of the Rocky Mountains. The great labor performed by Haven in gathering material from publications which were rare and inaccessible did much to correlate accumulated observations, and led to a hope, carried out forty years later, of publishing a complete archæological map of all the mounds east of the Rocky Mountains. For twelve years subsequent to Doctor Haven's memoir, however, nothing appears in the "Contributions" respecting the antiquities of the middle region of the United States, save a short communication by Whittlesey on "Ancient Mining on the Shores of Lake Superior." In 1872 Doctor Joseph Jones was aided by a small appropriation, and pursued investigations with ardor and success. The references to his work in the Reports from 1872 to 1876 show the wide range of studies pursued by him in historical and bibliographical directions. His memoir forms a volume of one hundred and eighty-one quarto pages, with many woodcuts, and a very full index by Professor O. T. Mason. This work, entitled "Antiquities of Tennessee," (1876) contains descriptions of burial caves and mode of burial, mounds, earthworks, forts, and relics, closing with general conclusions.

The exploration of the mounds was vigorously taken up in 1882 by the Bureau of Ethnology, and systematic excavations carried on in the field for eight successive years under the direction of Doctor Cyrus Thomas, aided by Doctor Palmer, Norris, Ragan, Reynolds, Middleton, and others. These researches were not confined to mounds, but it was found necessary to include in them all antiquities of the central region.

Many articles on the subject were published as a result of these studies, culminating in a voluminous report by Doctor Cyrus Thomas, the largest which has yet appeared on a subject which was inaugurated by the opening volume of the "Contributions."

MEXICO AND CENTRAL AMERICA

The rich field presented to the archæologist in Mexico and Central America has received the attention of the Institution, and several interesting publications on this subject have appeared in the "Contributions." In 1878 an important memoir by Doctor Habel entitled "Archæological and Ethnological Researches in Central and South America, with a Detailed Account of the Sculptures at Santa Lucia Cosumalwhuapa," was accepted by the Institution for publication. Doctor Habel had devoted seven years to exploration in this region, visiting many of the great ruins described by Stephens in 1841.

The main portion of this contribution was devoted to a description of the great monoliths at Santa Lucia Cosumalwhuapa, a village in the department of Esquintla, near the Volcan del Fuego. These stone slabs were discovered by a planter who came upon a large pile of buried monoliths in preparing his farm for cultivation. They were found to be richly sculptured and ornamented in *cavo-relievo* with representations of human figures of unusual carving, supposed to refer to the adoration of the sun, moon, and other anthropomorphic deities difficult to identify. Doctor Habel made true copies of the originals with great care and on his return to the United States was invited to visit Washington, where the expense of the preparation of his manuscript, and the plates, which were made under his personal supervision, was borne by the Institution. This publication attracted much attention,

and as in the later transportation of some of the monoliths to Germany—it is to be regretted that they did not all find a home in Washington—one of the most interesting was lost in the Pacific ocean, the figure of it given by Doctor Habel will always remain unique. The estimation in which the volume by Doctor Habel is held by scholars is voiced by the late Professor W. D. Whitney, who wrote: "It seems to me a story refreshing by its brevity and simplicity, very unlike the pompous and boastful way in which such things are often heralded. One may not agree with all the inferences drawn at the end, but that is a matter of very small importance; no two persons would arrive at precisely the same conclusions. So far as I can judge, the Institution has every reason to take pleasure and pride in the issue of such a contribution to American archæology."

The scientific discovery of these interesting monoliths and a publication of the memoir upon them led to several interesting studies by German archæologists and to the final transportation of the antiquities themselves to the Berlin Museum, by which institution replicas have been distributed to the collections of several European and American cities.

Of all the interesting ruins of Central America to which attention was called by Stephens and Catherwood, none excited more wonder at the culture they revealed than those of the great city of Chiapas called Palenque. A portion of one of the most interesting shrines of that ancient city, now known wherever archæology is cultivated as the Palenque Tablet, came into the possession of the Smithsonian, and was described and figured by Doctor Charles Rau in the twenty-second volume of the "Contributions." This stone tablet is one of the most precious archæological treasures in the National Museum. It was formerly the property of the National Institution for the Promotion of Science, to which it was pre-

sented in 1842 by Charles Russell, a former Consul of the United States in Mexico. It was transferred to the Smithsonian in 1858, and its relation to the famous group of the cross recognized by Doctor George A. Matile, who was engaged in making a cast of it at the request of Professor Henry. Del Rio and Dupaix gave a poor figure of it in position in the Temple of the Cross, but it was probably broken in 1832, and Stephens in 1839 noticed its scattered fragments. The first trustworthy representation we thus owe to Doctor Rau's memoir, as mentioned above.

The account of the Palenque treasure was followed by a valuable contribution on "Archæological Researches in Nicaragua," and preceded by "Observations on Mexican History and Archæology" by Brantz Mayer, both of which articles were timely additions to a knowledge of a great subject. Other smaller but no less important works on the "Antiquities of Guatemala" should not be overlooked, especially that of Bransford and Kneeland, both of which are frequently quoted.

WEST INDIES

The Smithsonian possesses a most valuable collection of ancient Carib art in stone, and has published several important works on the antiquities of the Antilles. Professor E. D. Cope in 1883 discussed the contents of a bone cave in the island of Anguilla, giving an interesting insight into cave life in a comparatively unknown quarter. The purchase of the Latimer collection of stone objects from Porto Rico enabled Professor O. T. Mason to prepare an elaborately illustrated article on idols, or zemes, and Carib stone implements, a picture of a style of stone working unsurpassed on the American continent. Somewhat later he was able to supplement this report by an examination of beautifully exe-

cuted drawings of the Guesde collection of similar objects from the island of Guadeloupe.

In the same year as the Centennial Exposition in Philadelphia, and directly connected with that work, a quarto volume was written by Professor Charles Rau on the "Archæological Collections of the United States Museum," and distributed by the Institution. This work was in the form of an illustrative catalogue, and, although not exhaustive in its treatment, served to give a wider knowledge than had been current of the wealth of archæological material in the museum. There can hardly be a question that this publication should take high rank with other influences which at that time quickened public interest in American antiquities, and led to a rejuvenescence of scientific activity in several centers of learning. But perhaps of special importance in that line ought to be mentioned the several articles on methods of archæological study which appeared at about that time. Of these the more important were, "Circulars in Reference to American Archæology," written by Professor Mason and signed by Professor Henry, Secretary of the Smithsonian Institution. Those interested in the antiquities of the mound builders were appealed to in a circular of somewhat different character, prepared by Doctor Cyrus Thomas, at the inauguration of his extensive explorations in this field.

There is probably no more perplexing problem presented to the anthropologists than the derivation of a prehistoric people of Easter Island, one of the most isolated islands of the Pacific Ocean. The colossal carvings in stone made by these people, their quaint hieroglyphic slats and hideous figurines, have attracted wide attention. A good representative collection from this island is now housed in the National Museum, and an exhaustive report, well illustrated, forms one of the most interesting of the contributions to insular archæology.

Several articles of a comparative nature treating of collections of archæological material in the museum have materially added to the progress of archæology. Among these may be mentioned a work, by Doctor Charles Rau, on "Prehistoric Fishing in Europe and North America." This large volume was published in two parts, forming an article of three hundred and sixty pages with four hundred and six figures. About one-third of the memoir was devoted to archæological relics of Europe, classified in the three epochs, of the palæolithic, neolithic, and bronze ages. The second part deals with archæological fishing implements, and relics of North America, and considers such topics as "Fishing Implements and Utensils," "Boats and Appurtenances," and "Aboriginal Representations of Fishes, Aquatic Animals," etc. The chapter on "Artificial Shell Deposits" is of great value. This work has a historical side no less important than the archæological, and embraces many early documentary and printed references to aboriginal fishing scattered in various writings, most of which are inaccessible to the public save with great difficulty. Doctor Rau was an industrious contributor to the Smithsonian Reports from 1864 to 1883, and his articles on "Agricultural Flint Implements," "Drilling in Stone without Metal," "North American Stone Implements," and "Ancient Aboriginal Trade in North America" testify to the breadth of his archæological work in special lines.

Although the greater part of the archæological industry of the Institution has been turned to the antiquities of America, other countries have not been neglected. The publications have reprinted important articles by masters in the science, as, Hamy, on the probable "Home of the Troglodyte"; Tylor, on the "Prehistoric Races of Italy," and Quatrefages, on "The Advent of Man in America." The Reports contain likewise articles by Evans on "The An-

tiquity of Man," Desor on "Palafittes of Lake Neuchatel," and Adler on "Oriental Antiquities."

One important publication on Egyptian archæology has been issued by the Institution. Gliddon, the Egyptologist, in 1842 presented to the national collection a portion of the lid of a mummy case from Sacara. This was regarded by Doctor Charles Pickering, of Boston, as older than the third dynasty, and its inscription, which unfortunately gives no indication of the date, appeared to him to have preceded an important change in the character of hieroglyphic writing. The lid had been divided into three parts, and distributed, and the missing parts could not be traced. Doctor Pickering, however, described the portion which came to the Smithsonian, and gave a large plate of it, which was a facsimile in size and color, representing the figures upon it with scientific accuracy.

LINGUISTICS

The Smithsonian Institution early recognized the value of linguistics in the study of anthropology, and from 1850 to 1876 a large amount of work was done in collecting the vocabularies of the American Indians. The keynote of the value of linguistics is well indicated in one of the early reports, from which I quote, "A language is not originally a thing of man's device, or the result of conventional art, but the spontaneous production of human instinct, modified by the mental character, the physical condition, and other peculiarities of the people or tribe among whom it had its origin, or by whom it is used. It is subject to definite laws of formation and development, and is intimately connected with the history of the migrations and affiliations of the people by whom it is spoken, and hence becomes an object of interest to the student of the natural history of man."

From its foundation to the present time efforts were made to collect Indian vocabularies as part of the ethnological work of the Institution, and in 1876 their number amounted to six hundred and seventy. They were placed in charge of Doctor J. H. Trumbull, of Hartford, Connecticut, for critical study. It was the intention of the Institution to publish these vocabularies in the "Contributions to Knowledge," and in separate form for general distribution among philologists. In that year, however, Major J. W. Powell, who had collected a series of Indian vocabularies from the inhabitants living near the Great Colorado River, requested that the manuscript material be turned over to him to be published in connection with his work. This proposition was accepted, the only conditions of the transfer being that in the publication of the material due credit be given to the founder of the Smithsonian, and that extra copies of the publication be furnished the Institution for distribution. The series of publications on linguistics began with an article by Doctor Francis Lieber, "On the Vocal Sounds of Laura Bridgman, the Blind Deaf Mute at Boston, compared with the Elements of Phonetic Language." The wonderful work of Doctor Howe in opening the mind of this person to outward impressions has become famous, and perhaps no more interesting problems are presented to the psychologist than those connected with the enlightenment of a mind apparently forever consigned to darkness. Doctor Lieber had exceptional advantages to study the sounds first used by Laura Bridgman as indicative of ideas, and his psychological and philosophical deductions naturally attracted wide attention among scholars. At the time of the publication of this work modern psychology as now understood was in its infancy.

For eighteen years missionaries among the Dakota Indians industriously collected material for a grammar and lexicon of

that language, which, under the auspices of the Historical Society of Minnesota, was arranged and edited by the Reverend S. R. Riggs. Although primarily prepared to meet the needs of missionaries, it was found to be an interesting contribution to ethnology, and its publication was recommended by several of the best philologists of the country. By coöperation with the Historical Society of Minnesota, and the American Board of Missions, which contributed about a third of the cost of the work, the Smithsonian Institution devoted the fourth volume of the "Contributions" to this valuable memoir.

The appearance of this memoir led to the preparation of others, which, although not all published, showed the wealth of material and the awakening interest in this branch of ethnographic study. The Institution gave its fostering help to this work, assisting in the elaboration of material, and coöperated with other institutions in its publication. Among these may be mentioned a "Grammar of the Choctaw," by the Reverend Harvey Byington, which was warmly recommended by Professor Felton, of Harvard and George Gibbs. It was published by the American Philosophical Society of Philadelphia, having been much improved by the author and Doctor D. G. Brinton, after the death of Mr. Byington. The growing trade with Oregon rendered timely the publication in 1853 of the "Vocabulary of the Jargon or Trade Language of Oregon," edited by B. Rush Mitchell, and Professor W. W. Turner, who at that time was librarian of the United States Patent Office. The interest of the latter scholar in philological studies appears also in the "Grammar and Dictionary of Yoruba Language," published in the tenth volume of the "Smithsonian Contributions." Yoruba is in Western Africa, east of Dahomey, and is peopled with a primitive race of simple and harmless character. The Reverend

Thomas J. Bowen, a missionary of the Southern Baptist Board, lived with these people for six years, and collected much information concerning the physical characters of the country, the manners, customs, and language of the inhabitants. With the aid of Professor Turner he revised and rewrote his notes, which, when published, became a memoir of great value to students of the languages of the African race. To show the value of this work to specialists, I need only refer to a commendation of it by the profound German Egyptologist, Lepsius.

The influence of Gibbs and Shea on the study of the linguistics of the aboriginal races of North America was most important. They found in the Smithsonian Institution a channel by which their ideas were impressed on the growing study of ethnology. Morgan's suggestion of an ethnological map, in a circular issued by the Institution, was adopted with zeal and broadened in its scope to embrace all fields of anthropology. He proposed to enlist the help of several institutions, as the Bureau of Indian Affairs, the Surveyor-General of the Land Office, the Hudson Bay Company, in the distribution of circulars calling for ethnographic information, and proposed the association of several well known scholars in perfecting his plan of an ethnological map of North America. He found in Professor Henry, then Secretary of the Smithsonian, an appreciative helper, and in Professor Whitney an adviser of great value. John G. Shea, of New York, had devoted much attention to linguistics, and at his own expense began the publication of a series of grammars, or dictionaries, which he styled a "Library of American Linguistics." This praiseworthy undertaking not only enlisted the sympathy of the Smithsonian, but also active aid and association in the work. A number of manuscripts presented to the Institution for publication were transmitted to Shea to be published

in the series above referred to, and arrangements made by which a considerable number of copies of each memoir were secured from the publisher for distribution. In this way the Smithsonian aided in the publication of grammars or vocabularies of the Mutsun language, spoken at the missions of San Juan Bautista and San Antonio, California, and the Yakima and Pima.

Instruction for research relative to ethnology and philology prepared by George Gibbs and printed and distributed to officers of the United States and other governments met with a gratifying response. As supplemental to that work blank forms for systematic records were sent out, resulting in valuable returns of vocabularies, implements, and other objects illustrative of the arts, customs, and mental condition of American races. The vocabularies were intrusted to Gibbs, whose work for many years was largely gratuitous. He contributed to the publications several valuable articles, of which his dictionary of the Chinook jargon and "Comparative Vocabulary" are good examples of his work.

The accumulated material on Indian linguistics passed into the hands of the Bureau of Ethnology at its foundation, and the continuation of its elaboration naturally will be found in the account of that department of the Institution.

The "Instructions for Research relative to the Ethnology and Philology of America," by George Gibbs, first published in 1861, stimulated investigation throughout the country, and fifteen years later the demand for this work had been so great that a second edition of more comprehensive plan was prepared under the direction of Major J. W. Powell. The elaboration adopted the following plan, as stated in the report for 1876:

"*First.* It is found necessary to enlarge the alphabet so as

to include a wider range of sounds which have been discovered in the North American languages.

"*Second.* It is necessary to enlarge the vocabulary so as to modify it somewhat as experience has dictated, and that new words may be collected.

"*Third.* It is desirable that many simple sentences should be given, so chosen as to bring out the more important characteristics of grammatical structure."

The new edition, with the above mentioned improvements, was widely distributed among Indian agents and traders, missionaries, and local students, and resulted in the collection of much data in the form of linguistic and other notes, and a harvest of objects illustrating the manners and customs of the aborigines of America.

Although the fruition of this plan will be considered in the account of the work of the Bureau of Ethnology, I may refer to the accomplishment of one of the plans of George Gibbs, so often referred to in the Reports of the Smithsonian Institution for 1862 and the following years. The plan of an "Ethnographic Map" was successfully carried out by Major J. W. Powell and his assistants as far as linguistic stocks were concerned, thus giving a valuable contribution to the cartography of the Indian tribes north of Mexico.

Of the many valuable articles on linguistics published by the Smithsonian Institution, those of Dorsey on the "Comparative Phonology of Four Sioux Languages" and Roehig "On the Language of the Dakota or Sioux" are noteworthy. The "Lectures on Linguistics" by Professor Whitney was a timely publication written by a master of philology, and given a wide distribution by the Institution. Doctor Cyrus Adler in his "Oriental Literature in America" treats a subject of ever growing interest to a large number of American

scholars. The valuable memoir of Lewis H. Morgan on "Systems of Consanguinity and Affinity of the Human Family" was a remarkable work by a profound scholar. Having been led by his studies of the system of relationship among the Iroquois Indians to certain conclusions in regard to consanguinity, Morgan was able to develop the fact that the same law holds likewise among other Indian tribes of America, and at his request circulars asking for information on these points were distributed to consuls, missionaries, and ethnologists by the Smithsonian Institution. This work was officially facilitated by General Cass, Secretary of State, by whom it was commended to diplomatic agents of the government in various lands. The effect of this circular in advancing anthropological knowledge was great not only in the special line of inquiries which it specially concerned, but also in other branches germane to social organization of primitive society.

The National Museum has accumulated enormous collections of objects illustrating the ethnography of different races of man. This material has served as the basis of many valuable researches, furnishing valuable data on technology, mythology, and many other departments of anthropology. Several monographic accounts of different races from the ethnographic standpoint enrich the publications of the Smithsonian Institution.

At the request of the Institution James G. Swan, an agent of the government, prepared an account of "The Indians of Cape Flattery," opposite Vancouver Island, in the northwestern corner of what was then Washington Territory. This article, published as a memoir, contained a full description of the manners and customs, myths, and ceremonials of these people, with a detailed account of implements, clothing, houses, and mortuary customs, and beliefs.

It drew largely in its illustrations from specimens in the museum, and was accompanied by a vocabulary of the Makah tribe. The Institution was fortunate in having this memoir edited by George Gibbs, whose valuable and enthusiastic work in other departments of ethnology has been commented upon elsewhere. A few years later Swan prepared another work on the Indians of the Northwest coast, which was published in the twentieth volume of the "Contributions to Knowledge." This article, consisting of eighteen pages of text, with seven plates, two of which were in color, treated of "The Haidah Indians of the Queen Charlotte Islands." The people considered in this publication are best known by their exquisite carvings of ivory, and the lofty heraldic poles, called totem posts, which are placed before their dwellings as indicative of the gentes of the occupants. The museum collection is especially rich in objects from the Indians described by Swan in these two memoirs, and their publication led to a new interest in northwestern coast villages. This rich vein of ethnographic material was found to extend along the whole coast from Washington Territory to the Aleutian Islands, and was successfully worked by Niblack and Dall. The former author published, in the Report for 1888, an elaborate monograph of "The Coast Indians of Southern Alaska," in which will be found a detailed account, with figures of many objects in the museum which were deposited there by him. A large and unique collection, which can probably never be duplicated, was made for the National Museum in this region by E. W. Nelson. John Murdoch, at one time librarian of the Smithsonian, had earlier been attached to one of the circumpolar stations at Point Barrow, Alaska. He thus had a rare opportunity to study the Eskimo of that high latitude, which he improved, bringing back much valuable information. His ethnographic report, extended by

studies of the great collection of Eskimo material in the museum, is the most important memoir on the people of the Arctic coast of Alaska which has ever been published. The publications of the Smithsonian Institution have been greatly enriched by the articles of Boas on "The Indians of the Northwest Coast," and the work of this eminent ethnologist has made him an authority in this interesting field of research. Many collections of objects used in ceremonials have been added to the museum by his industry, and his contributions to folk lore, mythology, and linguistics are widely known among scholars as most valuable additions to knowledge.

The ethnography of the pueblo area is a favorite child of the Bureau of Ethnology, and this study was much stimulated by the formation of that department of the Smithsonian Institution. The large collections of pueblo pottery, stone implements, ceremonial objects, basketry, blankets, and other specimens illustrating the primitive life of all the pueblos of the Southwest, made by Powell, the Stevensons, Cushing, the Mindeleffs and others, is unsurpassed in any museum. From the time this collection was brought in from the field, until the present, it has contributed material for specialists in several lines of study. Specimens from it have been, perhaps, more often figured than those of any other collection of pueblo objects. To barely mention the articles which contain illustrations taken from this collection would swell this account to undue proportions. The pottery, stone implements, ceremonial paraphernalia, and other objects represented in the richly illustrated report of Stevenson were drawn from this collection, as well as many figures in the articles of Mrs. Stevenson, whose devotion and industry contributed to the value of the collection.

The remarkable collections from the Orient, from China, Japan, and Tibet, the hermit nation, Corea, shows how broad

the scope of purely ethnographic objects is in the museum. Of the many publications on these collections, it may be invidious to single out any one, and not mention others. The articles by Hitchcock and Hough give an idea of the wealth of material from the far East, in the National Museum, while the beautifully illustrated and carefully prepared description of the collections from Tibet by W. W. Rockhill have been published in a typographical form worthy of their great merit. Of particular interest to the student of ethnography are the aborigines of Japan called the Ainos, a comprehensive collection of objects from which people has been well described by Hitchcock.

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A CLASSIFIED record of the yearly progress of science is of utmost importance, and merits the attention of an Institution so well equipped with exchanges as the Smithsonian. The bibliography of anthropology, year by year, has been published from 1879 to 1893, inclusive, and the Smithsonian is to be congratulated in being able to call upon Professor O. T. Mason for this work. This series, by one so signally fitted by breadth of knowledge of anthropological literature, contains not only a list of publications on this science during each year by different institutions and societies of Europe and America, but also a judicial summary of several, and valuable abstracts or notices of the more important current articles. In order to complete this series, the Smithsonian Report for 1879 gives an index to papers on anthropology from 1847 to 1878, thus carrying the bibliographical lists back to the time of the foundation of the Institution.

By the acquisition of the famous Catlin Gallery the Smithsonian Institution gave a permanent home to one of the most

valuable collections of Indian portraits which has ever been made. George Catlin was a wonderful man, and his work as artist and ethnologist among the wildest tribes of Indians did much to increase the scanty knowledge of the aborigines of North America. He was one of the first to live among the Indians, camping with them and following them in their migrations. His accounts of several of the tribes are about all that is known of them, and, as some of them have now disappeared, will ever remain the source of knowledge in the future. The original paintings of this artist have a unique value and their purchase for the national collection appropriate and necessary.

In order to make this collection as efficient among ethnologists as it was widely known, a descriptive account was published with copies in one of the publications of the Institution. A list of the photographic portraits of North American Indians in the gallery of the Smithsonian Institution appeared in the "Miscellaneous Collections" for 1867. The unparalleled facilities for photographing typical Indians who visit the capital have led to the collection of an unique assemblage of pictures of our aborigines nowhere equaled in the world. It was an opportunity which can never recur, for many of the famous Indians who sat for these photographs are no longer living.

The publications on somatology have taken a wide range, treating of physiology, anatomy, and craniology. Among other articles of merit may be mentioned those of Carter and Holmgren on "Color Blindness," Shute on the "Anatomy of the Brain," Turner and Romanes on "Heredity." Doctor Baker's "Ascent of Man" more properly belongs to another line of Smithsonian work, but may well be mentioned in our consideration of contributions by the Smithsonian to somatology.

TECHNOLOGY

The great collections of objects illustrative of arts and manufactures gathered from all quarters of the globe have offered unrivaled advantages for studies of technology. Several prominent specialists have availed themselves of these facilities, and publications on the arts have covered a wide field of human activities.

The study of ceramics has been given great importance, and the publications on this subject from time to time have attracted world-wide attention. In 1866 Doctor Rau opened the series with a valuable article on Indian pottery, a subject which was later treated in so exhaustive and artistic a manner by W. H. Holmes. From the rich storehouse of material in the hands of aboriginal potters, Cushing and others have drawn much in the preparation of their valuable papers on the primitive potter's craft and its origin and significance.

Professor O. T. Mason's studies of comparative technology were broader in scope, more varied in subjects. From this industrious worker, identified for so many years with the growth of the museum, have come some of the most learned and exhaustive articles which enrich the pages of the publications of the museum.

His work on throwing-sticks gave him a wide reputation for its comprehensive treatment, while that on basketwork, published in the same year, was of great importance. A natural complement of the former article was a treatment of the subject of bows and arrows, in which is found a wealth of information and illustration only possible with the resources of a large museum at the disposal of the author. Child-life in all its phases is of greatest ethnological interest, and in Mason's article on "Cradles of North American Indians" one

can obtain an aspect of technology which should not be overlooked. A cradle is in a way an index of the evolution of a method of carrying a burden, and the human beast of burden in its various modifications, from the time the aboriginal mother carried the child on her back, gives Professor Mason a subject for interesting studies.

The immense collections of ceramics from many Indian tribes have furnished most important material for several monographs. From a study of these collections, made by officers of the Smithsonian and acquired by purchase, almost every phase of the potter's technic has been discovered, and many peculiarities of symbolistic decoration made out.

From this source have been drawn most of the illustrations in the beautiful monographs of W. H. Holmes on pottery, while the types of many of the specimens used in the preparation of his articles on shell and bone working are found in the museum.

Doctor Walter Hough, adopting the thought that one could best study aboriginal arts by working with aboriginal tools, experimented with primitive fire-drills, and as a result he published an interesting article on "Fire-making Apparatus" of many rude or uncultured people. Joseph D. McGuire cultivated a somewhat different field, influenced by a similar thought. With no other implements than those used by primitive man, he was able to cleverly fashion any of the various types of stone implements which characterize lower stages of culture.

While the scope of the anthropological researches fostered by the Smithsonian Institution has not been limited to the study of the American race, a consideration of the preceding pages shows how large a part of this work has been devoted to American antiquities and aborigines. The reason for the predominance is not far to seek. While occupying a position

as one of the great scientific institutions and museums of the world, the Smithsonian is naturally an American institution, founded by individual munificence, aided in its development by appropriations from public funds of the United States. While renowned foreign scholars have deemed it an honor to be associated with its work, the majority of anthropologists who have aided in its growth have been American specialists on subjects connected with America. Few countries have a larger and more varied anthropological field to study than our own. Fifty years ago the relative proportion of the unknown to the known in American anthropology was much larger than at present. It is an inevitable result of these and other influences that, whatever its aspirations, the dominant influence of the Smithsonian Institution on the study of anthropology must be, as we can say with pride it has been, in fostering the study of American ethnology and archæology.

As a national institution, there is but one ideal possible for the Smithsonian Institution, and that the highest, the leading scientific center of the intellectual life of a great nation. In American anthropology it should stand, as it has stood, without a rival in this field, not one of several institutions fostering American science, but the leader, appealing to scholars through the most profound researches, and to the public and students through the most carefully arranged museum in the country.

GENERAL REMARKS ON THE ANTHROPOLOGICAL COLLECTIONS

The enormous collections of material in the exhibits of the Smithsonian Institution illustrating archæology or the distribution of man in time, and ethnography or geographical distribution, form but a part of those under charge of the curator. Its wealth is known to the special student who

seeks the museum for his researches. That which is not seen by the visitor is carefully preserved and freely placed before the special investigator. All great museums are treasure-houses to the student, repositories of unworked material awaiting the advent of specialists. The Smithsonian Institution thus draws visitors to the objects installed, and special students to the rich collections stored in appropriate places. Much of the material is unique, can never be duplicated, and so long as it lasts will draw to this Mecca of anthropologists both the sightseer and the investigator.

Although there are many sides to the discussion of the question of the influence of the installations of the anthropological material in the Smithsonian Institution, I can mention but one or two points germane to this subject. One aim of a museum collection is to attract and to teach the public something. Every museum strives to accomplish this object, but the means used often vary. In certain directions the work of the Smithsonian Institution in the installation of ethnological and archæological material is unique.

The value of models is recognized by all curators, and these representations have been used with great success in all the foremost museums of the world. The Smithsonian Institution had before it an exceptional problem in developing this side of its anthropological exhibit. Peculiar conditions presented themselves to those in charge of the illustration of American ethnology and archæology. While models were considered indispensable, there were no models in existence to illustrate aboriginal American life. European workmen, adepts in their craft, were unfamiliar with our Indians, and their attempts to represent them were often caricatures. American modelers had not yet turned their attention to this line of work when the Smithsonian Institution adopted the method and carried it to a high perfection. An Indian group

making pottery or basketry, a Navaho silversmith, tells a story much more effectually than can be told in any other way. In this method of installation the Smithsonian Institution is not only a pioneer as far as the American Indians are concerned, but preëminent among museums.

The models of pueblos and cliff-houses in the museum are also unique; their duplication elsewhere shows that they are appreciated as a method of installation, and yet it is not saying too much to declare that the Smithsonian Institution was also a pioneer in this kind of installation. In this connection may be mentioned an adaptation of photographs of ethnographic material which has attracted much attention among experts at home and abroad. I refer to the use of transparencies in windows. These pictures of American Indians, of pueblos, and similar objects have certainly not been carried to the same perfection elsewhere.

From the influences which have been enumerated, and others equally potent, anthropology in the last half century has made enormous strides. In this short time in the history of science many great ethnological museums have been born and grown to exert widespread influences. Trained anthropologists have taken the places of amateurs, ethnological researches have become more exact, publications more special. The mode of installation of ethnographic material has improved, a science of museums is beginning to be recognized. The history of the influences which have brought about all this growth interests every one who studies the glorious part which the Smithsonian Institution has played in the fifty years now closing. The new anthropology nurtured into vigor by great institutions reciprocates by claims which cannot be disregarded; it instinctively looks for future growth to that influence to which it owes so much in the past.

GEOGRAPHY

By Gardiner Greene Hubbard

President of the National Geographic Society

DURING the half century that has elapsed since the Smithsonian Institution was organized, more progress has been made in acquiring knowledge of the geography of the earth than in any previous century. More than a fourth of the globe, which in 1846 was practically unknown, and was represented by a blank on our maps, has been explored in this half-century; and in this work of developing our knowledge of unknown regions, the Smithsonian Institution has played a far more prominent part than is popularly supposed. Few expeditions have been equipped and sent out by it; but of the expeditions organized by the United States government for purposes of exploration, there are few which have not been aided by the Smithsonian Institution, either by additions to its personnel, by instruction, counsel and advice, or by the working up and publication of its results.

In these ways the fostering care of the Smithsonian Institution has been felt by many branches of science now rep-

resented by organizations under the general government. The creation of these organizations, which was in large part due to the Smithsonian Institution, constitutes one of its greatest services to mankind.

It was Professor Henry's idea that the Institution should make original investigations in all branches of geographic knowledge, institute explorations, and collect specimens of minerals, animals, plants, and ethnological objects for its museum, where they could be studied by specialists, and diffuse knowledge by publications based upon them. This plan contemplates increasing our knowledge, (A) by means of exploring expeditions sent out, either at its sole expense or jointly with other organizations; (B) by the collection of specimens for the museum illustrating the geography, geology, biology, and ethnography of the countries explored. It should diffuse the knowledge thus gained, (A) by the preparation of maps; (B) by the publication of its annual reports; and (C) by the publication of memoirs.

Among the many expeditions which the Smithsonian Institution has aided in a greater or less degree, a few only can be specifically mentioned.

NORTH AMERICA

If we look at the northern part of North America on a map of 1846, we shall find the shore line of the Arctic Ocean ill-defined and the outlines of the islands and the mainland frequently confused. The river Yukon on that map enters the Arctic Ocean near Point Beechey instead of flowing into Bering Sea, several hundred miles to the southward, as is now known to be the case. Although the general courses of the rivers were then laid down with some approach to correctness, this was more through theoretical than by actual know-

ledge. On one of the maps of this date, the Red River of the North flows south instead of north, connecting the great rivers flowing into Lake Winnipeg and Hudson Bay with the Minnesota and the Mississippi. Alaska, then little known, was the property of Russia.

Professor Henry took great interest in the exploration of the Arctic Ocean; and aided by his counsel, advice and instruction, the second Grinnell expedition, under Doctor Elisha Kent Kane, was undertaken in 1853, that of Doctor Isaac I. Hayes in 1860, and the Polaris expedition, under Captain Charles F. Hall, in 1871.

The western part of Canada was then controlled by the Hudson Bay Company. At its request Professor Henry prepared circulars to its officers, with suggestions and directions for exploration of its territory. In accordance with these suggestions much exploration was done between 1850 and 1870, at the joint expense of that company and the Smithsonian Institution. In this way valuable additions to our knowledge of its geography and biology were acquired.

In 1861 the Western Union Telegraph Company organized an expedition for building lines of telegraph overland through Alaska and Siberia to Europe. Robert Kennicott, William H. Dall, and George Kennan accompanied the expedition, partly in the capacity of representatives of the Institution, and made extensive explorations in Alaska and eastern Siberia; but before their work was finished, it was interrupted by the successful laying of the Atlantic cable. Notices of these explorations were published in the Reports of the Institution. Subsequently, when stations were established in Alaska and the Arctic regions of America for the purpose of obtaining meteorological data, the Institution selected observers to accompany the parties, and furnished other material aid; and the explorations made by

the parties stationed at Point Barrow and Lady Franklin Bay were in no small degree the result of the coöperation of the Institution. By such means a large portion of the Arctic regions of North America was explored, and extensive collections, especially of biologic and ethnologic subjects, were made.

In 1846 the greater part of the United States west of the one-hundredth meridian was unknown. The most western State was then Illinois, the region west of the Mississippi being an unsettled region where Indians and buffaloes roamed. Texas had just been admitted to the Union, but California and the greater part of the country west of the Rocky Mountains belonged to Mexico, and were ceded to the United States in 1848. The explorations of Lewis and Clarke, Pike, Long, Bonneville, and Frémont had laid down the general course of the main streams, and the general distribution of the mountain systems, but little or nothing was known of the details of the topography, and nothing whatever of the resources of the country. The only means of reaching California was by sailing vessels around Cape Horn. The Mormons were then located on the Mississippi River, and several years passed before they took up their dangerous march across the desert to Salt Lake.

Between 1849 and 1854 the United States government sent out a number of expeditions for the purpose of discovering practicable routes for railroads across this great desert region. These expeditions were conducted by the War Department, but they were aided in many ways by the Smithsonian Institution. They were accompanied by geologists, botanists and ethnologists, who received their instructions from the Institution; and the magnificent series of Pacific Railroad reports are in no small degree the work of the Institution. After these expeditions followed many

others, under the control of the War Department, which were aided in greater or less degree by the Institution; but they are too numerous to be mentioned here.

The early explorations of Professor F. V. Hayden, which were mainly geological in character, were aided by the Institution. In 1869 Major J. W. Powell, partly at the expense of the Smithsonian Institution, and partly at that of the Illinois State University, explored the Colorado River of the West, traversing it from Green River to the foot of its cañons in boats. During subsequent years he continued exploration of the plateau region drained by this river and its tributaries, under the Smithsonian Institution, mainly by the aid of direct appropriations from Congress. Finally, in 1879, the organizations of Major J. W. Powell, Doctor F. V. Hayden and Lieutenant G. M. Wheeler, of the United States Engineer Corps, were merged into the present United States Geological Survey.

During the earlier part of this period of fifty years before the general construction of railroads, the navigation of the Ohio and Mississippi rivers was of the utmost importance to the inhabitants of the Mississippi Valley, for it afforded the only means of intercommunication between the people living in the northern and southern parts of the valley of this river. Furthermore, the annual inundations of the Mississippi River were often the cause of great devastation to the cotton and sugar fields in the lower part of the great valley, as the banks of the river are lower than the river at its high-water mark. Moreover, the bar at the mouth of the river was a serious impediment to sea-going vessels. The Ohio and Mississippi rivers were examined by Charles Ellet, under the general oversight of Professor Henry, and the contributions of Mr. Ellet were published at various times by the Institution in 1849–'50–'51, and were of great value not only

as an aid to our knowledge of the physical geography of the rivers, but also as determining the steps to be taken, and which have subsequently been carried out, for improving the navigation of the rivers and the prevention of inundations.

Great wisdom was shown by the Institution in its earlier days in aiding other institutions unable to incur the whole expenses of an expedition, by furnishing the means for sending out skilled parties connected with such universities, thereby obtaining more satisfactory results and interesting broader circles than if the expeditions had been made solely by the Institution. Thus Professor Charles B. Adams, of Amherst College, was sent to the West Indies and Panama on two expeditions in 1851–'52, at the joint expense of the Smithsonian Institution and the College. In 1868, Frederick Sumichrast, of Kentucky University, was sent out to explore the Isthmus of Tehuantepec, and he prepared an account of his journey, which was made at the joint expense of the University and the Smithsonian Institution.

In 1868 the remains of a bone cave were found in the West India island of Anguilla and thoroughly examined by experts of the Smithsonian. This investigation throws light not only on the ancient life, but also on the geography of the West Indies in prehistoric times, and the importance of the research is shown, Professor Baird tells us, by the following considerations:

First. It is the first investigation of the life of the cave age in the West Indies.

Second. It gives the first reliable indication of the period of submergence, and hence of separation of the West India islands from the continent.

Third. It furnishes the best evidence as to the antiquity of man in the West Indies, and brings to light some very peculiar forms of animal life not previously known.

There is not space to mention the many reports of different travelers and collectors in the West India islands. No part of the world seems to have been so frequently visited by writers for the Smithsonian as the West India islands and the different countries in Central America.

ASIA

Passing now from America, we will consider the work of the Smithsonian Institution in extending our knowledge of the Old World. Ten years after the Institution was chartered, an exploring expedition was sent out by the United States, and by the able management of its commander, Perry, Japan was first opened to foreign trade. Since that time, and within the last thirty years, greater changes have taken place in Japan than ever before in any country—a country which had been closed to the rest of the world for over two hundred years, and where no changes had taken place in the manner, habits or progress of the people for many centuries.

The Japanese in many ways differ from their neighbors the Chinese and Koreans; though they resemble them in some of their habits and in their religion, yet their language is very dissimilar. Inquiries have therefore been made to ascertain their origin, and especially by Romeyn Hitchcock, who visited Japan in 1887 and 1889. On traveling into the northern part of the country his attention was called to the Ainos, who were supposed to have been the earliest inhabitants of that territory, and at some early period had been forcibly driven from the south, the richest portions of Japan, into Jeddo, the most northern and poorest of the islands. In visiting northern Japan to learn more of the Ainos, he heard of the Pit Dwellers, earlier inhabitants of Japan than the Ainos, but greatly inferior to them, who probably had been

driven from their pits by the Ainos. This report is of great value and interest, and was published in 1890 by the Smithsonian Institution.

The maps of fifty years ago show the general course of the rivers of China (with several ranges of mountains), having been largely constructed from the reports of Marco Polo, who traveled through China six hundred years ago, for little had been added to the knowledge of the interior of China since his time. During the past fifty years intercouse with China has been greatly increased, barriers have been thrown down, the country has been partially opened to missionaries and travelers, who have crossed and recrossed its territory, so that we have now a general knowledge of the whole of the Chinese Empire. Raphael Pumpelly was one of the first Americans who traveled extensively through China, Mongolia, and Japan between 1862 and 1865, and his researches were published by the Smithsonian Institution. He was the first to describe the great Loess formation of the Hoang-Ho, in northeastern China, which has been the chief source of its agricultural wealth and the means of subsistence of its vast population, and to ascertain the location of the vast coal beds and fields of iron and copper. Various facts have been ascertained in regard to the Loess formation, of interest to us, as the same formation has been found in Iowa and some other of the central States. These countries were again explored in 1881 by Pierre L. Jouy, who also visited Korea, and subsequently by John B. Bernadou, each of whom made large collections of the fauna of those countries and of the mortuary pottery of Korea. It must not be forgotten that the latter are not only valuable as interesting specimens of art, but also as giving us a very accurate knowledge of the resources of the country and the character and civilization of its inhabitants. Later William W. Rockhill, for several years con-

nected with the American Embassy in China, acquired sufficient knowledge of the Chinese language to converse in it, and also became acquainted with the habits and customs of the people, and thus was fitted to travel in that country. He traversed China, Mongolia, and Tibet, though he was not successful in reaching Lassa. A year or two later he visited these countries a second time; and an account of the countries and peoples visited by him in both of these explorations is given in the reports published by the Smithsonian. Southeast of Tibet is the beautiful Vale of Kashmir and the deep valleys of the Himalayas, with cañons through which the Indus runs, as much deeper than our cañons as the mountains are higher than those of our own country. These were visited by Doctor William L. Abbott in 1893 and 1894.

AFRICA

Fifty years ago the interior of Africa was unknown; the maps of Africa delineated the coast-line, the course of the Niger, the lower Nile, a small tract south of the Desert of Sahara in the region of Timbuctoo, and Lake Tchad and Cape Colony, while all the rest was unknown. It was reserved for our times—for Livingstone and Stanley and Speke and Baker, and a host of other eminent travelers, to explore the different parts of Africa, until now the Dark Continent has become better known than the interior of Asia. Negroes from our country were sent to Liberia, under the auspices of the American Colonization Society, and founded the first republic of Africa. This republic was visited by Reverend R. R. Gurley in 1824, 1858, and 1867, who in his earlier trips collected many specimens for the Smithsonian museum. Near Liberia, and east of Dahomey, is Yoruba, the most densely populated portion of Africa,—a country inhabited by

a peculiar people more highly civilized than most other negro tribes. It was visited by Reverend J. J. Brown in 1856–'57, who prepared a grammar and dictionary of their language, of great value to ethnologists, with a description of the country and people. In 1889, Reverend A. C. Goode visited the Gaboon, a little to the north of the Congo, and about the same time Héli Chatelain explored the coast of Africa south of the Congo, near Loando, one of the most flourishing settlements in Africa, founded by the Portuguese, where they have large plantations and a railroad extending into the interior. Their reports were published in 1891 and 1892. The river Congo was visited by J. M. Camp between 1892 and 1895, who collected many valuable specimens for the Museum, and also by Dorsey Mohun, who sailed up the river to the territory of the Ujiji people in eastern Africa. There is one country in Africa, Morocco, partially civilized, of which we know less than of any other similar country, as its inhabitants oppose the entrance of travelers or any foreigner into their country. Morocco has had a civilization of its own for many centuries, and from there the Moors entered and conquered Spain, and there they found a refuge when driven from Granada. This country was visited in 1889 by Talcott Williams, of Philadelphia, who prepared a most interesting account of his visit for publication by the Smithsonian Institution.

A number of scientific expeditions have been sent out by our government to witness eclipses of the sun; one in 1889 to South Africa to observe the eclipse which took place that year. In this connection the coast of the Congo region was visited by William Harvey Brown, of the National Múseum, who later accompanied an expedition sent out by the South African Exploring Company into South Africa, the country of which we have recently heard so much; for here

are the great diamond mines of Rhodesia and the gold fields of the Transvaal, which so nearly involved England in a war with the Boers, and were the cause of the rising of the Matabeles and Mashona tribes.

Eastern and northeastern Africa have also been visited by two American explorers, who associated themselves with the Smithsonian Institution by presenting large and valuable collections of natural history and ethnological objects to the National Museum. Doctor William L. Abbott visited that part of eastern Africa now claimed by the Germans, in the vicinity of the great snow mountain of Kilimanjaro, from 1889 to 1893, going from there to Madagascar. In 1892, William Astor Chanler, of New York, after a full conference with Doctor G. Brown Goode, determined on an expedition to British East Africa, for the purpose of exploring the source of the Yuba and the rivers of Abyssinia. His journey was of great interest. He visited many localities in northeastern Africa, and a report of his journey was published in 1893.

Besides the publications of the Smithsonian Institution which have been mentioned in the preceding pages, in connection with the story of its relations to exploration and travel, the Institution has issued numerous publications of a geographical character. For five years, from 1882 to 1886, inclusive, it published in its annual report a summary of progress in geography, in which, in a few pages, the progress made by mankind, in acquiring knowledge of its environment, was set forth. It has published a collection of geographical tables in several editions, the earliest of which were edited by Professor Arnold Guyot, and the latest by Professor Robert S. Woodward, which are of the greatest value to geographers and scientific travelers.

It has published many short papers, among which are "Promotion of Further Discovery in the Arctic and Antarctic

Regions," and "The Present Standpoint of Geography," by the well-known English geographer, Clements R. Markham; "The Renewal of Antarctic Exploration," by another celebrated English geographer, John Murray; "The Mediterranean, Physical and Historical," by R. L. Playfair; "Development of the Cartography of America up to the year 1570," by S. Ruge; "Geographical Latitude," by W. B. Scaife; "The North Polar Basin," by Henry Seebohm; "Physical Condition of the Ocean," by W. J. L. Wharton; "How Maps are Made," by H. O. Blakie; "Antarctica, a Vanished Austral Land," by W. B. Forbes; "Antarctic Explorations," by G. S. Griffiths; "Evolution of Commerce" and "The Relations of Air and Water to Temperature and Life," by Gardiner G. Hubbard; "Stanley and the Map of Africa," by J. S. Kelte.

A compilation of data regarding altitudes in the United States was first undertaken by the Institution. A generation ago attempts were made by it to obtain profiles of the railroads of the country, and great progress had been made in this work when it was taken up on the one hand by the Signal Office, and on the other by the Hayden Survey, and since carried forward by that organization and its successor, the present Geological Survey. The only outcome of this collection of altitudes made by the Institution is the production of a small hypsometric map of the United States, prepared by Charles A. Schott, and published in the United States Statistical Atlas of 1874.

Many maps have been published by the Institution, but in practically all cases they are embodied in reports which they serve to illustrate, and therefore require no separate mention.

BIBLIOGRAPHY

By Henry Carrington Bolton

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LORD RAYLEIGH, in his presidential address at the Montreal meeting of the British Association held in 1884, said:

"By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as 'known,' and it is often forgotten that the re-discovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory."

This well formulated truth, coming from so high an authority, emphasizes very strongly the immense importance of bibliographical publications, a fact which has always been appreciated by the Smithsonian Institution. Having been especially established to promote "the increase and diffusion of knowledge among men," its officers have always regarded as peculiarly within its province the means for making the vast stores of learning in print available to students of science. This feature was an object of particular interest to the first Secretary, Joseph Henry, and in his "Programme of Organization," he recommended that the library should contain,

"first, a complete collection of the transactions and proceedings of all the learned societies in the world; and second, of the more important current periodicals, publications, and other works necessary in preparing the periodical reports." Subsequently he further recommended that "catalogues of all the different libraries in the United States should be procured," as well as "catalogues of memoirs, and of books and other materials for rendering the Institution a *centre of bibliographical knowledge.*"

Again, in his Report for 1851, Henry remarked: "One of the most important means of facilitating the use of libraries (particularly with reference to science), is well-digested indexes of subjects, not merely referring to volumes or books, but to memoirs, papers, and parts of scientific transactions and systematic works."

He then refers to Doctor Thomas Young's "Catalogue of Books Relating to Natural Philosophy and the Mechanical Arts," published in 1807, and remarks: "I know of no richer gift which could be bestowed upon the science of our day than the continuation of this catalogue to the present time. Every one who is desirous of enlarging the bounds of human knowledge should, in justice to himself as well as to the public, be acquainted with what has previously been done in the same line; and this he will only be enabled to accomplish by the use of indexes of the kind above mentioned."

These brief extracts show the mental attitude of Henry toward bibliographical labors. Reference will be made later to his splendid contribution to bibliography in suggesting the work which led to the publication by the Royal Society of London of the "Catalogue of Scientific Papers."

As in many other departments of activity, the foundations laid by Henry for bibliography have been constantly built upon by his successors in the secretaryship. Their policy

has always been to foster bibliographical researches, both by the labors of the staff of the Smithsonian, as well as by scholars and specialists to whom the pages of its publications have been freely opened.

The "Smithsonian Deposit," in the Library of Congress, is especially rich in the publications of learned societies; the Smithsonian "Annual Report," "Miscellaneous Collections," and "Contributions to Knowledge" are replete with indexes, catalogues, bibliographies, and check-lists to every branch of knowledge, supplying to some extent the tools for the use of bibliographers.

JEWETT'S PLAN FOR A GENERAL CATALOGUE

PROFESSOR CHARLES C. JEWETT, Assistant Secretary of the Institution and Librarian, in 1850, proposed an elaborate plan for compiling a general catalogue of all the books in the United States with reference to the libraries where each might be found. To accomplish this Professor Jewett devised a method of electrotyping titles separately, one on a block, and he drew up a set of "Rules" for cataloguing to secure uniformity on the part of the different librarians. Professor Jewett seems to have anticipated some of the features of the modern linotype method of printing catalogues, as the process is stated to be "peculiarly adapted to the stereotyping of separate titles or even of single lines." His plan contemplated coöperation between the libraries in the United States and the Smithsonian Institution on this basis: the titles of books received were to be transcribed on a uniform system, and then to be stereotyped by the Smithsonian, the latter Institution to pay the extra expense of stereotyping or such part as might be agreed upon; the stereotyped titles to remain the property of the Smithsonian Institution;

and each library to have the right of using all the titles in the possession of the Institution, as often as desired, for the printing of its own catalogue by the Smithsonian Institution, paying only the expense of making up the pages, or press-work, and of distributing the titles to their proper place. And lastly, the Smithsonian Institution to publish, as soon as possible, and at stated intervals, a "General Catalogue of all Libraries" coming into this system.

In urging the economy of this scheme, the interesting fact was brought forward that the printed catalogues of libraries in the United States comprised a total of 450,000 titles, but of these not more than 150,000 titles were different. This was in 1850; now there are several single libraries which have on their shelves more books than all the combined libraries of the United States then possessed.

Professor Jewett proposed an extension of the copyright law to all books, and the publication of a monthly "Bulletin" as well as a "General Catalogue" every five years. He favored an alphabetical arrangement of titles on account of the difficulties surrounding any attempt at classification. His scheme provided for a superintendent to revise the titles so that they conform to the "Rules," and to supervise the stereotyping.

The "Rules for Preparing Catalogues" embody detailed instructions as to the transcription of titles, the choice of headings, the treatment of foreign names in alphabeting, the character of cross-references and the arrangement of data; they are followed by examples and a library check-list showing in what American libraries (thirteen selected) the books catalogued are to be found. The "Rules" have formed the basis of all subsequent publications of like character, although certain ones have been materially changed.

The plan of stereotyping separate titles was carried on for several years by the Smithsonian Institution, but the

scheme for a "General Catalogue" was never accomplished, though a beginning was made. Jewett further published "Notes of Public Libraries in the United States" (1851), a work which, though admittedly incomplete, excited great interest; and the distribution of the volume brought into the Institution a large amount of statistical information pertinent to the subject.

HENRY AND THE ROYAL SOCIETY

The monumental work of the Royal Society of London, a "Catalogue of Scientific Papers, 1800–'83," had its origin in a communication addressed by the first Secretary of the Smithsonian Institution to the British Association for the Advancement of Science.

As early as 1854, Henry conceived the plan of preparing an "American Scientific Bibliography," and sought to enlist the coöperation of the British Association for the Advancement of Science in procuring, with its large resources, a similar classified index for British and European scientific literature. Henry's proposal was favorably received by the British Association and referred to a committee comprising Fellows of the Royal Society; this committee approved the suggestion, presented a general outline of the proposed work, and eventually succeeded in interesting the Royal Society itself in the undertaking. Ten years later, the Royal Society, aided by a government grant, published the first part of its splendid "Catalogue of Scientific Papers." In the preface occur the following words: "The present undertaking may be said to have originated in a communication from Doctor Joseph Henry, Secretary of the Smithsonian Institution." The eleven quarto volumes, covering the period 1800 to 1883, form one of the greatest tributes to Henry's

sagacity. Being an author-catalogue arranged alphabetically, its use has been hampered by the lack of a subject-index, but scholars have been recently delighted to learn that the Royal Society contemplates supplying this very important deficiency.

The Royal Society has recently opened correspondence with the Smithsonian Institution concerning a continuation of the Catalogue on an enlarged plan for the period beginning with the year 1900.

In a letter dated March 31, 1894, Professor Michael Foster, Secretary of the Royal Society, says:

"The Smithsonian Institution is, on historical grounds, so closely connected with the efforts of the Royal Society in cataloguing scientific papers, that I am directed to add to the circular letter herewith sent, a few words expressing the hope of the Committee of the Royal Society, which has the matter in hand, that they may have in a special way the assistance of your valuable body in coming to a decision on so important a question."

The circular alluded to states that the Royal Society contemplates the preparation of a continuation of the catalogue, and inquires as to the feasibility of its being compiled through international coöperation, and invites suggestions as to the best methods for carrying out the plans.

Secretary Langley replied promptly, and his letter is thus referred to in the report of the International Catalogue Committee dated July 25, 1895:

"It is a great gratification to the Committee that the matter has been taken up in a most cordial manner by the Smithsonian Institution, the Secretary of which, in his reply, refers to the desirability of a catalogue of the kind suggested as being so obvious that the work commends itself at once."

An International Conference was held in London in July, 1896, to consider this important undertaking, in answer to invitations sent by Lord Salisbury to twenty-one countries, and the results of its labors are familiar to all.

CHECK-LIST OF SERIALS

FROM time to time the Smithsonian Institution has published check-lists and catalogues of the publications of learned societies and of periodicals received and placed on file in the library. The first of these bears the date 1853, "Check-list of periodicals received in the reading-room," issued only as a separate. This was followed by others in 1855, 1856, 1859, 1862, and culminated in the stout volume of nearly 600 pages, octavo, issued in 1866, entitled: "Catalogue of Publications of Societies and of Periodical Works, belonging to the Smithsonian Institution, January 1, 1866." At the time of its publication it was the "most complete work on the bibliography of publications of learned societies which has yet appeared in the English language."

In 1882, Mr. William J. Rhees, chief clerk of the Smithsonian Institution, contributed an important bibliography to the series, entitled: "Catalogue of Publications of the Smithsonian Institution (1846–'82), with an Alphabetical Index of Articles in the Smithsonian Contributions to Knowledge, Miscellaneous Collections, Annual Reports, Bulletins and Proceedings of the United States National Museum, and Report of the Bureau of Ethnology." A second edition brought down to date was published in 1886; this forms an indispensable key to the articles, volumes, and numbers issued by the Institution from its organization to the date of issue, a period of forty years.

The alphabetical index contains in a single alphabet the

names of authors and the titles of the specific articles, with references to the series, volume, and number where each can be found.

In this connection may be mentioned the several editions of the "List of Publications of the Smithsonian Institution for sale or exchange," edited by Mr. Rhees and issued at frequent intervals for many years. Also the "List of the Publications of the Bureau of Ethnology, with Index to Authors and Subjects," by Frederick Webb Hodge, which bears the date 1894.

RECORDS OF PROGRESS IN SCIENCE

In the "Programme of Organization," approved by the Re gents, December 8, 1847, provision was made for "the publication of a series of reports giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge not strictly professional" . . . . "The reports to be prepared by collaborators eminent in the different branches of knowledge."

These reports have constituted for more than forty years an important part of the appendixes to the "Annual Reports." In 1880 they took the form of a systematic "Record of Scientific Progress," and most of which contain full bibliographies, and this feature was, in part, continued until 1895. The reports comprised the following topics by the persons named, at the dates given:

"Anthropology," 1879–'93, by Otis T. Mason.

"Astronomy," 1879–'84, by Edward S. Holden; 1885–'92, by William C. Winlock. From 1883 accompanied by partial bibliographies. That for 1887 was published in the "Miscellaneous Collections."

"Botany," 1879–'83, by W. G. Farlow; 1887–'88, by F. H. Knowlton.

"Chemistry," 1879–'81, by George F. Barker; 1882–'86, by H. Carrington Bolton; 1887–'88, by F. W. Clarke. [A bibliography of chemistry for the year 1887, by H. Carrington Bolton, was published in the "Miscellaneous Collections."]

"Geography," 1881–'84, by F. M. Green; 1885, by J. K. Goodrich; 1886, by William Libbey, Jr.

"Geology" (including Petrography, Vulcanology, and Seismology), 1879–'80, by George W. Hawes; 1881–'83, by T. Sterry Hunt; 1886, by N. H. Darton; 1887–'88, by W J McGee.

"Meteorology," 1879–'84, by Cleveland Abbe. "Dynamic Meteorology," by Cleveland Abbe, 1887–'88; 1889, by G. E. Curtis.

"Mineralogy," 1879–'80, by George W. Hawes; 1882–'88, by Edward S. Dana.

"Paleontology" (North American), 1884–'86, by J. B. Marcou; 1887–'88, by H. S. Williams.

"Petrography" 1887–'88, by George P. Merrill.

["A Bibliography of Works on Building Stones," forms Appendix E to George P. Merrill's paper on "The Collection of Building and Ornamental Stones in the United States National Museum; A Handbook and Catalogue," published in 1886.]

"Physics," 1879–'86, by George F. Barker.

"Vulcanology and Seismology," 1883–'86, by C. G. Rockwood.

"Zoölogy," 1879–'86, by Theodore Gill.

CONSTANTS OF NATURE

THE eminent English mathematician, Charles Babbage, proposed, as early as 1856, a great work, entitled "The Constants of Nature and Art," intended to contain all facts which can be expressed in numbers, in the various branches of knowledge, such as the atomic weight of bodies, specific gravities, elasticity, tenacity, specific heat, conducting power,

melting-points, etc. This undertaking would require the coöperation of a number of institutions, but it would necessarily consist of many independent parts, any one of which would be of immediate value.

Recognizing the utility of this suggestion, the Institution began to collect material on several of the topics embraced in the general plan, under the direction of Professors John and Joseph Le Conte, but the outbreak of the Civil War interrupted the work. In 1873, however, Frank Wigglesworth Clarke offered a series of "Tables of Specific Gravities, Boiling-points and Melting-points of Bodies," compiled from the best authorities, and this was issued as Part I of the "Constants of Nature" in the same year. Three years later (1876) the same industrious worker published "A Table of Specific Heats for Solids and Liquids," forming Part II of the series named. Other volumes of this valued collection followed:

Part III, "Table of Expansion by Heat for Solids and Liquids," by F. W. Clarke, 1879.

"First Supplement to Part I; Specific Gravities, etc.," 1876.

Part IV, "Atomic Weight Determinations," by George F. Becker, 1880.

Part V, "Recalculation of Atomic Weights," by F. W. Clarke, 1882.

Of Part I, a new edition was issued in 1888, and of Part V, a new edition was issued in 1897.

These works have become invaluable to all scholars and investigators in the physical sciences.

SMITHSONIAN TABLES

In connection with the meteorological observations conducted by the Institution, Professor Guyot compiled a volume of

"Meteorological and Physical Tables," which was published in 1852. A second edition was issued in 1857, a third in 1859, and a fourth, prepared with the assistance of William Libbey, Jr., was published in 1884.

The demand for these valuable tables soon exhausted the edition, and in 1890 Secretary Langley planned a new work in three independent parts, "Meteorological Tables," "Geographical Tables," and "Physical Tables." Of this series the first volume, "Meteorological Tables," was published in 1893; a second edition being required a year later.

The second volume of the series, "Geographical Tables," prepared by R. S. Woodward, was published in 1894; the third volume, "Physical Tables," prepared by Thomas Gray, was issued in 1897.

BIBLIOGRAPHIES OF INDIVIDUALS

In William J. Rhees's "Scientific Writings of James Smithson" (1878) there is a list of the publications of the founder of the Smithsonian Institution.

The "Memorial of Joseph Henry," published by order of Congress in 1880, contains a "List of the Scientific Papers" of the distinguished first Secretary of the Institution.

In 1883 the National Museum began a series of bibliographies of American Naturalists, of much importance. These include the following, issued as "Bulletins of the United States National Museum" at the dates named:

I. "The Published Writings of Spencer Fullerton Baird," 1843–'82, by G. Brown Goode. (1883.)

II. "The Published Writings of Isaac Lea," by Newton Pratt Scudder. (1885.)

III. "Bibliography of Publications relating to the collection of fossil invertebrates in the United States Na-

tional Museum, including a complete list of the writings of Fielding B. Meek, Charles A. White, and Charles D. Walcott," by John Belknap Marcou. (1885.)

IV. "The Published Writings of George Newbold Lawrence, 1844–'91." By L. S. Foster. (1891.)

V. "The Published Writings of Dr. Charles Girard," by G. Brown Goode. (1891.)

These monographs form splendid monuments to the naturalists named, exhibiting more perfectly than is possible in bibliographical sketches their genius, industry, and fertility of resources.

Four other bibliographies of individuals, not included in the above series, have appeared in the Smithsonian Reports:

VI. "A list of the Writings of Alexander Dallas Bache," by Benjamin A. Gould.

VII. "List of the Writings of Arnold Guyot," following the Biographical Memoir by James D. Dana.

VIII. "List of the Writings of Asa Gray, accompanying the Memoir by William G. Farlow.

IX. "The Publications of Elias Loomis," attached to the Memoir by H. A. Newton.

BIBLIOGRAPHY OF SCIENTIFIC PERIODICALS

VOLUME XXIX of the "Miscellaneous Collections," issued in 1885, comprises a single work, bearing the title: "A Catalogue of Scientific and Technical Periodicals, 1865 to 1882, together with Chronological Tables and a Library Check-list," by Henry Carrington Bolton. This contains the titles of the principal periodicals of every branch of pure and applied science, published in all countries from the rise of their literature to the close of the year 1882; it embraces over

five thousand titles in twenty languages, not including, however, transactions of societies, or medicine. Following the Catalogue are ninety-one pages of "Chronological Tables," arranged in columns by years, giving a synchronal conspectus of all those periodicals having any considerable number of volumes, and showing the precise number of the volume published in any given year. To this succeeds a concise index of subjects under ninety-four heads, arranged alphabetically. A novel feature of this comprehensive work is the library check-list indicating the library or libraries in which each periodical may be found; each of the one hundred and twenty-seven principal libraries of the United States and Canada being designated by a symbolic abbreviation.

A new edition of this "Catalogue," brought down to the year 1895, with about 3500 new titles, is in preparation by Doctor Bolton. It will contain a new library check-list.

BIBLIOGRAPHY OF THE UNITED STATES NATIONAL MUSEUM

Bibliographies of the United States National Museum have been prepared by G. Brown Goode, annually, since 1881; these comprise: I. Publications of the Museum. II. Papers by Officers of the Museum. III. Papers by Investigators, not Officers, of the Museum, based on Museum material.

The record for 1894 contains the new genera and species described in the publications of the Museum for that year, in a supplement.

BIBLIOGRAPHIES OF SCIENCE

Anthropology. Exceedingly important works on bibliography, in relation to the North American Indians, have been published by the Bureau of American Ethnology. The Bureau

has projected five series of bibliographies: those relating to linguistics, amusements, industries, institutions and opinions (mythology, folk-lore, etc.), and has made substantial contributions in each. Mr. J. C. Pilling's bibliographies of the Algonquian, Athapascan, Chinookan, Eskimo, Iroquoian, Muskhogean, Salishan, Siouan and Wakashan languages, as well as his "Proof-sheets of a Bibliography of the Languages of the North American Indians" (1885), are monuments of the author's erudition and industry.

George H. Boehmer compiled an "Index to Anthropological Articles in Publications of the Smithsonian Institution," published in the Annual Report for 1879; it covers the period from 1847 to 1878.

Captain John G. Bourke's "Medicine Men of the Apache," in the Ninth Annual Report of the Bureau of Ethnology, is accompanied by a bibliography.

The "Study of Prehistoric Anthropology," by Thomas Wilson (1888), contains a bibliography of the subject.

A partial bibliography of the "Ethnology of the Eskimo," by John Murdoch, accompanies his essay on "The Ethnological Results of the Point Barrow Expedition," published in the Ninth Annual Report of the Bureau of Ethnology.

Another partial bibliography of the "Central Eskimo," by Franz Boas, is published in his essay on the subject contained in the Sixth Annual Report of the same Bureau.

Astronomy. Besides the bibliographies accompanying the Records of Progress in Astronomy, noticed elsewhere, two others should be named.

"Index-Catalogue of Books and Memoirs relating to Nebulæ and Clusters," by Edward S. Holden. (1877.)

"Synopsis of the Scientific Writings of Sir William Herschel," by Edward S. Holden and Charles S. Hastings. (1880.)

Botany. Sereno Watson prepared a comprehensive "Bibliographical Index to North American Botany; Part I, Polypetalæ." (1878.) This contains citations of authorities for all the recorded indigenous and naturalized species of the flora of North America, with a chronological arrangement of the synonymy.

Doctor Horatio C. Wood, Professor of Botany, University of Pennsylvania, published in the "Contributions to Knowledge" a "Contribution to the History of the Fresh Water Algæ of North America," to which is added a bibliography.

Chemistry. The Committee on Indexing Chemical Literature, appointed by the American Association for the Advancement of Science in 1882, two years later secured the consent of the Smithsonian Institution to publish such chemical bibliographies as might be recommended by the committee. By means of this coöperation chemical students have been provided with several indexes of a technical character, whose value increases as their number multiplies; they include:

"Index to the Literature of Uranium," by H. Carrington Bolton, 1885.

"Index to the Literature of the Spectroscope," by Alfred Tuckerman, 1888.

"Index to the Literature of Columbium," by Frank W. Traphagen, 1889.

"Index to the Literature of Thermodynamics," by Alfred Tuckerman, 1890.

"A Bibliography of the Chemical Influence of Light," by Alfred Tuckerman, 1891.

"Bibliography of Aceto Acetic Ester," by Paul H. Seymour, 1894.

"Indexes to the Literature of Cerium and Lanthanum," by W. H. Magee, 1895.

"Index to the Literature of Didymium," by A. C. Langmuir, 1895.

More comprehensive than these special works is the "Select Bibliography of Chemistry," compiled by Henry Carrington Bolton and published in 1893. This volume covers the period 1492 to 1892, and embraces the titles of the principal books on chemistry published in all parts of the world. For convenience the titles are grouped under seven heads:

I. Bibliography; II. Dictionaries; III. History; IV. Biography; V. Chemistry, pure and applied; VI. Alchemy; VII. Periodicals. Within these sections are more than twelve thousand titles in twenty-five languages.

According to Secretary Langley, it is "a work of reference of such value that it is believed it will be a necessity to every chemical investigator."

Doctor Bolton has in preparation a supplement which will contain about eight thousand additional titles, including a new section, No. VIII, devoted to "Dissertations and Theses."

Natural History. Doctor Charles Girard, one of Baird's assistants in natural history, published in 1852 a "Bibliographia Americana Historico-Naturalis" for the year 1851. This work includes the doings of American naturalists, the labors of foreign authors in reference to American natural history, and abstracts of papers relating to foreign natural history published in American periodicals.

Ornithology. In the "Proceedings of the United States National Museum,"[1] Elliott Coues published "Fourth Instalment of Ornithological Bibliography, being a List of Faunal Publications relating to British Birds."[2]

This extensive bibliography undertakes to do for British birds what the author had previously done for American birds; the latter were treated in three previous instalments of this Universal Bibliography of Ornithology; these are:

[1] Volume II, page 359, 1879. [2] "Miscellaneous Collection," Volume XIX.

First Instalment. In appendix to "Birds of the Colorado Valley."[1]

Second. In "Bulletin of the United States Geological and Geographical Survey of the Territories."[2]

Third. In the same "Bulletin."[3]

In the preface to this List of Faunal Publications, the distinguished authority on birds names the rules that governed his action as a bibliographer, which deserves the attention of others. He says: "In conducting this work I habitually regard the *title* as inviolable,— to be transcribed in full, verbatim, literatim, et punctuatim"; and again, "No title in this Bibliography has been taken at second hand." The annotations accompanying titles are critical, erudite, and entertaining.

Baird's "Review of American Birds in the Museum of the Smithsonian Institution" (1864–'66), contains a fund of bibliographical matter, though not specifically prepared as a bibliography. This statement is also true of Baird's Catalogue, published in the "General Report on Birds," contained in the Pacific Railroad Reports.[4] This catalogue was succeeded by Elliott Coues's "Check-list of North American Birds"[5] (Salem, 1873), and by Ridgway's "Nomenclature of North American Birds" (1881). These were followed by the "Code of Nomenclature and Check-list of North American Birds," published by the American Ornithologists' Union in 1886 (second edition, 1895), which contains references to the original description of each species. This work was prepared by a committee of five, including Elliott Coues and Robert Ridgway, Curator of Birds of the United States National Museum.

[1] Miscellaneous Publication, United States Geological Survey, No. 11.

[2] Volume v, No. 2 (1879).

[3] Volume v, No. 4 (1880).

[4] Volume IX (1858).

[5] Published also as an Appendix to Coues's "Field Ornithology" (1874), a second edition of which appeared in 1882.

A chronological "List of the Books and Papers Relating to the Great Auk" is appended to Frederic A. Lucas's account of the "Expedition to Funk Island."[1]

Oriental Literature. A "Bibliography of Oriental Literature in the United States during 1888" is appended to the "Record of Progress of Oriental Science in America during 1888," by Doctor Cyrus Adler.

Physics. The principal contributions to bibliography under this head have been named as forming parts of the series "Constants of Nature," and the "Smithsonian Tables." Besides these, however, may be mentioned the "List of the Principal Authorities Consulted," by William Harkness, in preparing his address on "The Progress of Science as Exemplified in the Art of Weighing and Measuring," delivered before the Philosophical Society of Washington in 1887.

Surgery and Medicine. Doctor William W. Keen's lecture on the "Surgical Complications and Sequels of the Continued Fevers"[2] is accompanied by a "Bibliography of Works on Diseases of the Joints, Bones, Larynx, the Eye, Gangrene, Hæmatoma, Phlegmasia." (1876.)

The "Report on the Pharmacopœias of All Nations," by Doctor James M. Flint, United Sates Navy, originally printed in the "Report of the Surgeon-General of the United States Navy" for 1882, has been adopted for circulation by the Smithsonian Institution. It contains critical reviews of the Pharmacopœias of the following countries: Argentine Republic, Austria, Belgium, Brazil, Central American States, Chili, China, Cuba, Denmark, England, France, Germany, Greece, Hayti, Hawaiian Islands, Hungary, India, Italy, Japan, Liberia, Mexico, Netherlands, Norway, Paraguay, Portugal, Russia, Spain, Sweden, Switzerland, Turkey, United States, Uruguay, Venezuela.

[1] "Report of the United States National Museum, 1888."

[2] Toner Lecture, No. 5.

Vulcanology and Seismology. A "Bibliography of Volcanoes, Earthquakes and Geysers of Iceland," compiled by George H. Boehmer, was published in 1885. It forms an appendix (of twenty-nine pages) to Mr. Boehmer's translation of Thoroddsen's "Oversigt over de islandske Vulkaners Historie."

The "Bibliography of Vulcanology" (1883–'86), by Charles G. Rockwood, Jr., has been mentioned under the Records of Progress.

Zoölogy. The "Nomenclator Zoölogicus" of Agassiz, published in Solothurn in 1842–'46, was succeeded by a volume bearing the same title, compiled by Marschall, and issued in 1873. In 1882 Doctor S. H. Scudder published a new "Nomenclator Zoölogicus,"[1] to which was added a "Universal Index to the Genera and Species named in the Works of Agassiz, Marschall, and Scudder, as well as in the Record of Zoölogical Literature." This Universal Index embraced over eighty thousand names. Doctor Leonhard Stejneger is engaged on a supplement to Doctor Scudder's work, which will embrace about twenty thousand additional names; the author hopes to complete this bibliography within a year.

Perhaps the most important contributions to the bibliography of zoölogy are from the pen of that erudite and industrious scholar, Doctor Theodore Gill; the following is a partial list of his treatises:

"Arrangement of the Families of Mollusks" (1871); "Arrangement of the Families of Fishes" (1872); "Arrangement of the Families of Mammals" (1872); "Catalogue of the Fishes of the East Coast of North America" (1873); Bibliography of the Fishes of the Pacific Coast of the United States" (1882); "Bibliography of the Reports of Fishery Commissions" (1874); "Materials for a Bibliography of

[1] "Bulletin No. 19 of the United States National Museum."

North American Mammals," by Theodore Gill and Elliott Coues, in "Monographs of North American Rodentia," by Elliott Coues and Joel Asaph Allen (1877).

The "Catalogue of the Described Diptera of North America," by C. R. Osten-Sacken (1878), is accompanied by many bibliographical notes.

In 1863–'64 W. G. Binney compiled a "Bibliography of North American Conchology Previous to the Year 1860," published in two parts; Part I contains the writings of American conchologists generally, and Part II the works of foreign authors relating to the shells or mollusks of North America. Each part is accompanied by an index of authors. Together these comprehensive works fill over nine hundred pages of the "Miscellaneous Collections" (1863–'64).

A large number of bibliographies accompany, incidentally, papers published in the "Proceedings of the United States National Museum," in the "Annual Reports of the Bureau of Ethnology," and in other series issued by the Smithsonian Institution, of which space available prevents enumeration.

THE COÖPERATION OF THE SMITHSONIAN INSTITUTION WITH OTHER INSTITUTIONS OF LEARNING

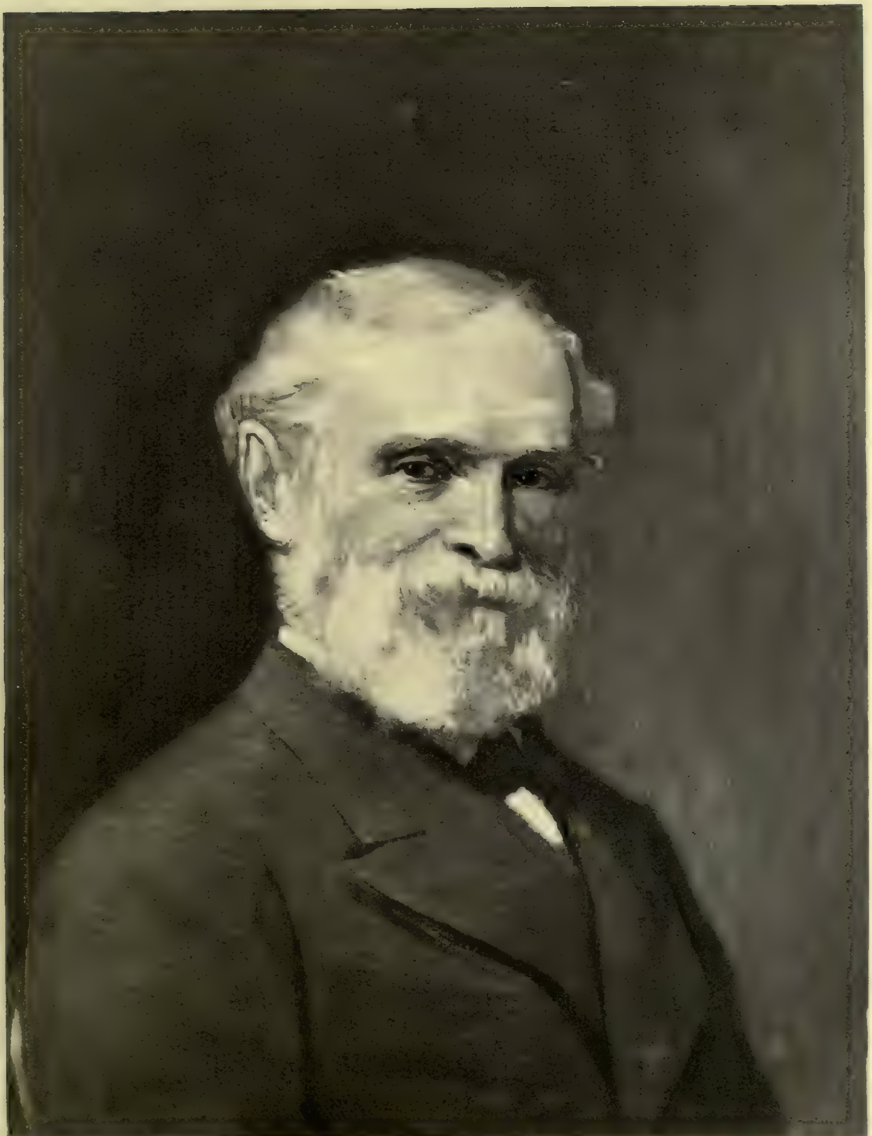
By Daniel Coit Gilman

President of Johns Hopkins University

ONE of the officers of the Smithsonian, in recounting the services of one of its departments, has said that they might be expressed in three words, Record, Research, and Education; and these are doubtless the most important functions of the entire Institution, if it is to proceed upon the line that was indicated by Washington and reaffirmed by Smithson—the advancement and diffusion of knowledge. But there has been another factor in the organization, and one that cannot be too frequently named or too highly extolled. That coefficient is coöperation. In a complex establishment almost everything depends upon the spirit with which its functions are performed, and the intelligence which guides its work. Old Mortality, Doctor Dryasdust, and Dominie Sampson were devoted to record, research, and education; but these characters were not the types of Smithsonian historians, investigators, or teachers.

It will not be proper to speak of the one who is living,

however pleasant this would be; but in praise of the two who are gone too much can hardly be said. Neither Henry nor Baird sought popularity. They were so much absorbed by their duties that they had not the leisure requisite for easy and familiar relations with the multitude. Henry rarely, Baird hardly ever, if at all, appeared as a public speaker. Yet they were always at the service of those who for any good reason desired of them counsel, or sought for information. No one could come into relations with either of these great men, orally or by correspondence, without being impressed with his desire to be coöperative. As they grew old, they did not enjoy attendance upon large assemblies, even of a scientific character; but in the early days of the American Association for the Advancement of Science they were foremost among its supporters. To the end of their days, they were not only efficient aids to all the learned men of the country, but they had the disposition, far more uncommon, to be patient with and helpful to the uneducated and ill-informed, the men who ride hobbies and the men who turn cranks. They were examples to the country of industry, fidelity, suggestiveness, and kindliness. These personal qualities governed their official action during the period of forty years in which they guided the Institution. Those who are familiar with the intellectual development of this nation must admit the justice of a claim put forth in these words, that "the most important service which the Smithsonian Institution has rendered to the nation — intangible, but none the less appreciable — has been its fifty years of constant coöperation with the government, with public institutions, and with individuals, in every enterprise, scientific or educational, which needed its advice, support, or aid from its manifold resources." Each secretary in his own way has been free, and has felt free, to open new roads and



enter fresh fields when the public good required it and the funds at command permitted extension. Each head of an important bureau, in his turn, has likewise contributed plans, suggestions, and methods to the unique institution with which he was connected. There has been but one restriction, laid down by the first secretary, and thus explained by Asa Gray: "In view of the limited means of the Institution, it ought not to undertake anything which could be done, and well done, by other existing instrumentalities. So, as occasion arose, Henry lightened its load and saved its energies by giving over to other agencies some of its cherished work."

It would have been easy for the managers to maintain an exclusive theory,—to organize an academy of limited membership sitting with closed doors,—to claim precedence for the scientific officers of the United States government,—to surround all proceedings with an air of mystery and reserve,—and to claim that territory once occupied by the Smithsonian belonged forever to the original tenant, and should not be invaded. But nothing of this kind has been done in a period of fifty years. On the contrary, from its inauguration until now there is an unbroken record of friendly relations with every agency in the land devoted to the encouragement of learning. Without any patronage, without the power to bestow much pecuniary assistance, without the bestowal of diplomas, medals, or other badges of distinction, without any official or paternal control, without even the disposition to criticize or correct, the Smithsonian has been and is the great auxiliary of science and education throughout the length and breadth of the land.

One of the earliest acts of the administration was peculiarly adapted to a country in which everybody is encouraged to be interested in the proceedings of the government. Correspondents were enlisted in every part of the United States,

and great consideration was paid to their inquiries and suggestions. Many of these collaborators, perhaps a large majority, were already connected with colleges, schools, and local associations having a scientific purpose. Others were isolated, lonely students or observers, far from good instruments and books, deprived of intercourse with men of like pursuits. Some were persons of great ability and influence; some were very humble. Many were enrolled as local meteorologists, and were led to keep accurate records of the weather, and send their reports to Washington. The study of local natural history and archæology was encouraged in these and other correspondents. The formation of libraries and museums was promoted by many agencies, among which the loan on deposit of objects to be exhibited and the gift of valuable publications were especially noteworthy. It is difficult in these days, when traveling is easy and when endowments, large and small, have been provided in every part of the land for the benefit of science, to appreciate the educational influence of the Smithsonian, in places far distant from the capital, during the first fifteen or twenty years of its active operations. The actual, almost universal, appreciation of the value of science among the American people is doubtless due in a very considerable degree to the influences referred to. There has been no "conflict" between men of letters and men of science in our schools of learning, and the apprehensions of religious teachers with respect to the tendencies of scientific doctrines have been transient and mild. Far and near, the quiet, unobtrusive influence of the Smithsonian has contributed to this result.

The mode in which the Smithsonian publications were distributed aided not a little the building up of libraries. To possess these works was the laudable ambition of many people. The annual reports were widely distributed. They

might be obtained from a member of Congress. They contained suggestive and stimulating papers in many branches of knowledge—papers, moreover, that could not be found elsewhere, or translations of articles accessible only to the few. The publications which were printed under the name of "Miscellaneous Collections" were not to be obtained by everybody. They were not meant for general readers, but for students. The scholar, however, whether young or old, who showed a special bent could readily obtain access to such papers in this series as were of interest to him. The quarto "Contributions" were given to libraries of considerable importance. Many communities were thus stimulated to enlarge their collections of books in order to present a fair claim for the reception of these stately volumes.

To facilitate the exchange of printed papers among the vast corps of correspondents, a system of international exchanges was begun in 1852. It must be remembered that when this plan was initiated it was difficult to maintain relations with distant countries, especially beyond the western part of Europe. The opportunities afforded by the booksellers, the express companies, and the mails were then quite inferior to those now existent. Even to-day great advantages are derived from the Smithsonian system, and its curtailment or abolition would be a serious interruption to the maintenance of friendly intercourse between the scientific men of this country and those of distant lands. Some idea of the extent of this work may be formed from the statement that the number of enrolled correspondents is not far from twenty-four thousand, of whom seventeen thousand are in foreign lands. A million and a half of packages have thus been distributed in forty-three years. All this is to be credited to the account of coöperation.

Publication is an important function of a scientific foun-

dation. In early days there were those who thought the issue of popular tracts, like the "Penny Magazine," or other juvenile and elementary books, would be most useful. But the secretaries took a different view. In their opinion, the private publisher might be relied on to secure and set forth, at very low prices, works for which there was a large demand. What was needed in this country, at that time, was encouragement for the publication of learned memoirs, often elaborate and voluminous, which appealed to a very select company of readers, and could not possibly be made to pay. This service has been performed from the beginning, when it issued an original memoir by Squier and Davis, on the aboriginal mounds of the Mississippi Valley, until the present time, when thirty quarto volumes of "Contributions to Knowledge" have appeared. But coöperation was not restricted to typographical assistance. Books, apparatus, specimens, and laboratory facilities have been generously accorded to investigators and writers. The "Contributions" have been supplemented by the "Miscellaneous Collections," consisting, usually, of less elaborate or less extended papers, as well as by the publications of the National Museum and the Bureau of American Ethnology.

Many persons favored the establishment of a great library as an essential part of the Smithsonian; for it was early obvious that in addition to the purchase, large and valuable series, the publications of governments and of learned societies, would be received as gifts and by exchanges. The collectors of books are usually miserly, desiring to get all they can and to keep all they get, but another disposition was manifested here. The Congressional Library, it was already evident, was destined to become the National Library. Now, instead of building up a rival, or forcing the government to duplicate costly books, the authorities

of the Smithsonian transferred the principal parts of their collection to the custody of the Congressional, and gave to it yearly accessions. The magnitude of this renunciation is apparent from the simple statement that more than three hundred thousand volumes and parts of volumes have thus become a part of the National Library, constituting perhaps one fourth of its possessions. In the new building a separate hall is assigned to this important department.

The chapter on Meteorology illustrates the principle of Henry. As the study of the climate of this country seemed of great importance, he devised methods, provided instruments, prepared the requisite mathematical tables, and enlisted far and wide the services of observers and recorders. He initiated and for years maintained this great work, and reached results which demonstrated its importance; and then, when the government, with all the possibilities of army service on the frontier and in stations remote from ordinary settlement, indicated its readiness to establish a weather bureau, he passed over all this work with its valuable archives to the new organization.

The growth of the National Museum, and its management, furnish additional illustrations of the coöperative spirit of the Smithsonian. At the time of the Centennial Exhibition in Philadelphia many great collections were brought together from remote countries. Baird was quick to see what a valuable possession they would be in Washington. Many of them were offered to our government, on the understanding that they should be properly displayed. Already the Smithsonian was the custodian of important collections made by the explorers of this country in our Western Territories and in foreign lands, including the objects brought together by the Wilkes expedition. Baird saw the opportunity to combine these elements and institute a national

museum. In this he succeeded, Congress being interested and willing to make the requisite appropriations for a building and for administration. The generous contributions of private persons, and the results of public expeditions now brought together, show what may be accomplished by co-operation. The last report of the Director, acknowledging the accession of one hundred and twenty-seven thousand specimens within a year, attributes this increase almost entirely to a warm interest in the welfare of the museum on the part of individuals, many of whom have at one time or another received some courtesy from the officials of the Smithsonian Institution.

Within the same year not far from forty thousand specimens were distributed to universities, colleges, museums, and normal schools, and the like distribution has been in progress for years. Four hundred and sixty-seven "lots" were sent to the museum for examination in the year 1895, and the reports of the curators were extended outside the United States and Europe to Canada, Central and South America, Mexico, Australia, New Zealand, India, Java, Borneo, the Philippine Islands, and various islands of the Pacific Ocean.

One of the most remarkable characteristics of the Smithsonian has been its power of adaptation to changing circumstances. This is shown not only by its renunciation of the library idea, and of the meteorological bureau, but by the expansion of other work. The Bureau of Ethnology, for example, has its own accomplished director and staff, and it is supported by special appropriations from Congress. Yet it has grown up under the protection of the Smithsonian, and has shared in its reputation for scholarship, sagacity, and economy. The evolution of this bureau is an interesting chapter in institutional history. The responsi-

bility of studying the habits of the aboriginal inhabitants of this continent, and of preserving, ere they totally perish, the knowledge of their languages, religions, arts, manners, and customs, was recognized when the Institution was first organized. The earliest quarto publication was a token of this interest. For many years the Catlin portraits stared every visitor in the face. The exploring expeditions in the trans-Mississippi brought back curious relics of primitive men, which were exhibited and studied by many young and enthusiastic investigators. The head of the Geological Survey, under whom parties were annually sent forth into distant and unknown regions, was keenly alive to the interest attached to anthropological inquiry. Nothing was more fitting than that he in due time should become the director of the Bureau of American Ethnology.

Quite different was the growth of the Fish Commission, an independent organization of which Baird was the originator and the head, from its beginning, and until his death. Technically, the credit of this branch of the government service does not belong to the Smithsonian. It stands on its own foundation. But it will undoubtedly be admitted that without the knowledge, the official encouragement, and the fine coöperative spirit of the second secretary, this commission, which has been so significant in its economic and in its scientific work, and has brought so much renown to the country, would not, in the present generation at least, have attained to its usefulness and distinction. It is here worth while to note that each of the secretaries has added important features to the Smithsonian which have had widespread influence upon the development of science. This will appear fully in the historical chapters. The coöperative spirit of Henry in initiating the Weather Bureau, of Baird in developing the National Museum, the Fish Commission,

and the Bureau of Ethnology, of Langley in establishing the Astrophysical Observatory and the National Zoölogical Park, and in advancing the art of aëro-navigation, deserves the highest praise.

No attempt has been made in this chapter to give the details of the Smithsonian management,—but only to indicate the impressions it has produced upon the mind of one who has had no official connection with the establishment. Constant intercourse with the collaborators, in Washington and in distant parts of the country, as well as in foreign lands, has never revealed one word of censorious criticism respecting the spirit which has governed the administrations of Henry, Baird, and Langley. Coöperation, the fundamental idea that has here been discussed, may be mechanical and formal, governed by petty regulations and accompanied by ceremonious exactions. But that is not the kind of coöperation to which this record has called attention. On the other hand, it has not been the coöperation of a spendthrift, throwing away the opportunities of usefulness and influence. In conclusion, the Smithsonian has been never ready to take up, and has always been ready to give up, those undertakings which other institutions and individuals might be disposed to assume and sustain with efficiency. Second, it has lent encouragement to thousands of workers whose work would have failed without a moderate amount of pecuniary assistance. Third, it has always been ready to enlarge its domain and sustain the burden of fresh responsibilities when it has appeared to be the wish of Congress or of the scientific men of the country that it should do so.

THE INFLUENCE OF THE SMITHSONIAN INSTITUTION

UPON THE DEVELOPMENT OF LIBRARIES, THE ORGANIZATION AND WORK OF SOCIETIES, AND THE PUBLICATION OF SCIENTIFIC LITERATURE IN THE UNITED STATES

By John Shaw Billings

Director of the New York Public Library

THE more one becomes familiar with the early history of the Smithsonian Institution, and with the ideas, plans, and work of its organizers and first officers, so far as these can be ascertained from the annual Reports and from some of its special publications for the first twenty years of its existence, the more will he become convinced that this was a time of much seed-planting in many and various fields, and that we are only now just beginning to see the character and magnitude of the very great harvests which are to result therefrom.

It is proposed in this paper to consider very briefly the influence which the Smithsonian Institution has exerted upon library and bibliographical work in the United States, upon the organization of societies of various kinds, and upon the

publication of reports, memoirs, and other forms of contributions to knowledge of the general government, by the several States, and by the various societies in this country, through the powerful stimulation which it has given, both by example and by precept, to work of this kind as special features of the second of its great objects: "the diffusion of knowledge."

The fifth section of the Act which organized the Institution required that it should form a library; and the eighth section provided that it should make an appropriation not exceeding $25,000 annually for the gradual formation of a library composed of valuable works pertaining to all departments of human knowledge. To this end, also, the tenth section of the Act directed that one copy of all copyrighted books, engravings, maps, etc., published in the United States, should be sent to this library.

In the original program of organization Professor Bache proposed to render the Institution a center of bibliographical knowledge to which students from all parts of the country could apply, by letter or otherwise, for information as to what books existed on particular subjects and in what library they could be found. In accordance with this idea, the first librarian, Mr. C. C. Jewett, began by collecting a large number of works on bibliography, and endeavored to procure copies of catalogues of all libraries in this country. It was at first proposed to secure three copies of each of such catalogues: one to be preserved in its original form, the others be cut up so that each title could be pasted on a separate card, these cards to be arranged in drawers so as to form a general catalogue. After something had been done in this direction, this work was set aside in favor of a system proposed by Mr. Jewett for producing printed catalogues by means of stereotyped plates of individual titles; by which

means he proposed to obtain a general catalogue of all the books in the country, which catalogue should contain references to the various libraries from which each book might be obtained.

Much time and money were spent in vain on this scheme, and it is evident that neither Mr. Jewett nor the managers of the Institution had at first any adequate idea of the magnitude or cost of the work which they proposed to undertake, or of the great development of American libraries which was to occur in the near future. At the time this plan attracted a good deal of attention, and there is no doubt that Mr. Jewett's "Notices of the Public Libraries of the United States," published by the Institution in 1851, and his rules for cataloguing, published in 1853, did exert a great influence on the formation and arrangements of a great number of the libraries of this country.

Professor Henry, the first secretary, soon perceived that the formation and maintenance of a great library would leave the Smithsonian Institution no funds for work which he had more at heart. It was found that the copyright law was rather a burden than an aid, and upon his representation it was finally so modified as to relieve the Smithsonian of the duty of receiving the publications which it provided for. Finally, through his exertions, the library of the Institution was transferred to the Congressional Library, under an agreement that it should be kept separate; that all expenses for binding and care of the books should be paid for by the general government; and that the Institution should have the right to withdraw the books at any time, upon payment of the expense which had been incurred. The number of volumes which were thus transferred was about forty thousand, largely the publications of learned societies which had been received in exchange for publications of the

Institution, and which formed a collection of records of the progress of the world which was unequaled in the United States, and hardly surpassed in other countries.

The growth of this special collection was a very rapid one. In 1853 it had already attained 25,000 volumes, and in 1895 it included 314,499 volumes, and formed over one quarter of the National Library.

A most important influence was exerted by the communication addressed by the secretary of the Institution to the British Association for the Advancement of Science, setting forth the importance of the publication of lists of titles of memoirs or papers contained in all the transactions of learned societies of the world, and offering to coöperate in this work. The result of this suggestion was the undertaking of this work by the Royal Society of London, which has now published ten large quarto volumes of the "Catalogue of Scientific Papers." The latest development of this movement was the calling of an international conference, which met in London in July, 1896, to consider a plan for cataloguing scientific literature in such a way as to make readily accessible the bibliography of any particular subject coming within the scope of such an index.

The development of public libraries in the United States since 1850, the date when the Smithsonian Institution began to exert its influence in this direction, has been marvelous. Jewett's "Notice of Public Libraries," referred to above, gave the statistics for the year 1849, showing that the number of libraries containing 1000 volumes and upward was 423, and the aggregate number of volumes in these libraries was 2,105,652. In 1891, according to the Report of the Bureau of Education, there were 3804 such libraries, containing about 27,000,000 volumes. In 1849 there were but five libraries containing over 50,000 volumes and upward, the largest being

that of Harvard College, with 84,200 volumes. In 1891 there were 98 such libraries, and 30 of these had 100,000 volumes and upward.

To the growth of many of such libraries the Smithsonian Institution has largely contributed directly by supplying them with its own publications and with books obtained through its system of international exchange, and indirectly through the stimulus which it has given to bibliographical work and to the publications of societies.

When it undertook this work, the wisdom and foresight of the organization was shown by the fact that many of the library methods which have become prominent were foreshadowed in the first report of the Institution.

Soon after the organization of the Institution it undertook to create and maintain a system of international exchange between the scientific and literary societies of the United States and those in other parts of the world. Prior to 1850 exchanges between such societies were made difficult, in part by the ignorance of some of them with regard to the existence and publications of others; in part by the custom-house requirements of different countries, which often caused great delay and considerable expense; and in part by the fact that each society had to provide its own agents and the means of transmitting its own documents and packages. Through the influence of the Smithsonian Institution and its agents in other countries most of the custom-house difficulties were done away with. The need on the part of individual societies of supplying agents disappeared, and by the publication of lists of correspondents and lists of publications of learned societies and of periodicals received, the Smithsonian Institution furnished libraries and associations with information as to their deficiencies, and with data as to the channels through which desiderata might be obtained.

The story of the development and progress of the system of international exchanges of the Institution is a very interesting one, but it would occupy too much space to include it in a paper of this kind.

The first volume of the Smithsonian "Contributions to Knowledge," published in 1848, was widely distributed to the libraries and societies of foreign countries, as far as the existence of such institutions was known; but the total number of copies thus circulated was only 173. At the present time the number of foreign institutions receiving the Smithsonian publications is 2588, and the number of institutions in the United States is 2866.

In 1867 the Smithsonian Institution initiated another system of foreign exchange in addition to the one for learned societies and scientific men, which had at that time fully developed. This second system was intended to include everything printed at the expense of the United States government, no matter how trivial or apparently unimportant; and a complete set of these publications was to be sent to each government which agreed to make an equally exhaustive return. By 1879 this work had been fairly begun, and thirty-two sets of documents were being disposed of to as many governments.

For a number of years this work was done entirely at the expense of the Institution, but finally Congress voted an appropriation for a portion of the sum annually required for this purpose. Under the provisions of the international exchange the United States has sent out a very much greater number of publications of the government than it has received. This was in part due to the much greater amount of matter published by the United States than by any other government, but it also largely depended upon the fact that other governments did not undertake to furnish annual lists

of all official documents and to charge some department with the collecting and forwarding of them.

The magnitude of the operations of this department of the Institution may be estimated by the fact that during the fiscal year 1894–95 the total number of packages received was 107,118, and the number of cases shipped abroad was 1364. The number of government publications shipped abroad to various sources was 23,023.

The example set by the Smithsonian Institution in publishing and widely distributing valuable contributions to knowledge, and the advice and recommendations of its secretaries and their co-workers, have exerted a powerful influence upon the several departments of the general government in inducing them to encourage their officers to make scientific investigations and explorations, and to prepare careful and elaborate reports, in the belief that these would be published at the expense of the government. No doubt this has resulted in the publication by the government of a considerable amount of matter the cost of which could have been much more judiciously applied in other directions; but this is really a small affair in comparison with the vast educational work which has been accomplished both as regards the great number of readers of and the contributors to these "public records."

Many societies of various kinds in this country have been induced to make special efforts to publish reports of transactions in order to secure for their members some of the benefits of the Smithsonian system of exchanges; that is to say, that they might have something to give in return for the publications of other societies.

All this has led to the production of a very considerable amount of valuable literature which does not primarily circulate in trade channels and is not influenced by commercial

considerations, and it has also been an important factor in the higher education in this country. It has created a demand for skilled observers and for scientific teachers and writers, and the knowledge that good work would be published and brought to the notice of those competent to appreciate it in all parts of the world has had quite as much to do with the meeting of this demand as has the mere pecuniary compensation offered for the work.

RELATIONS BETWEEN THE SMITHSONIAN INSTITUTION AND THE LIBRARY OF CONGRESS

By Ainsworth Rand Spofford

Librarian of Congress

IT was a signal good fortune which preserved the valuable library of the Smithsonian Institution from destruction by the fire of 1865, which so seriously damaged the building, and destroyed the Stanley Indian Gallery. Immediately following that event, Professor Henry, then at the head of the Institution, impressed by the peril which the collection of books had just escaped, sought a conference with the joint committee on the Library of Congress, in conjunction with the librarian. He developed to them a plan for securing the library from any future danger, while it might be brought at the same time to enrich the great library of the government. In the view of Professor Henry, several highly desirable objects would be accomplished by the union of the two libraries at the Capitol. As two spacious and fire-proof wings, constructed of solid iron, had just been added to the Congressional Library, there was then ample room for the orderly arrangement of the Smithsonian collection there, instead of attempting to continue it in the

narrow quarters, already overflowed, which it occupied, and which were greatly needed for other purposes during the reconstruction of the Smithsonian building. The removal would also relieve the Smithsonian fund of the expense of a library, including salary of librarians, and the cost of binding books, leaving so much more of the annual income free to be devoted to the promotion and publication of original researches in science. The latter having always been the cardinal object of the Institution, in Professor Henry's view, he had early taken the ground that the collection of a library should be kept somewhat subordinate, and confined mainly to the publications of scientific societies and aids to scientific study, leaving to the general government the more comprehensive aim of building up in the city of Washington a library of universal range.

On the other hand, it would clearly be to the advantage of the Library of Congress to receive so extensive an accession to its collections; and the annual additions of scientific transactions, through the Smithsonian exchanges, would compensate for the expense of binding, cataloguing, and care of such a collection, in the incidental saving of many purchases which would otherwise be essential for the Congressional Library in its progress toward completion.

These views, after due conference and comparison of advantages, prevailed with the committee representing Congress, as well as with the Regents of the Institution; and the result was the passage of the Act of April 5, 1886,[1] with the provisions following:

"The library collected by the Smithsonian Institution under the provisions of an act approved August tenth, eighteen hundred and forty-six, shall be removed from the building of said Institution, with the consent of the Regents

[1] "United States Statutes at Large," volume XIV, page 13.

thereof, to the new fire-proof extension of the Library of Congress, upon completion of a sufficient portion thereof for its accommodation, and shall, while there deposited, be subject to the same regulations as the Library of Congress, except as hereinafter provided.

"The Smithsonian Institution shall have the use thereof, in like manner as it is now used, and the public shall have access thereto for purposes of consultation.

"All the books, maps, and charts of the Smithsonian Library shall be properly cared for and preserved in like manner as are those of the Congressional Library, from which the Smithsonian Library shall not be removed except on reimbursement by the Smithsonian Institution to the Treasury of the United States of expenses incurred in binding and in taking care of the same, or upon such terms and conditions as shall be mutually agreed upon by Congress and the Regents of said Institution.

"The Smithsonian Institution, through its Secretary, shall have the use of the Library of Congress, subject to the same regulations as Senators and Representatives."

The removal of the library to the Capitol was effected during the winter of 1866–67. It then comprised about forty thousand volumes, now increased to more than eighty thousand volumes (about two hundred and fifty thousand titles), besides a great assemblage of pamphlets and unbound serials; and it completely filled one entire gallery of the newly constructed south wing of the Congressional Library, and overflowed into another gallery below. The Smithsonian librarian, Doctor Theodore N. Gill, was transferred with the library to the Capitol, and continued to catalogue and superintend the collection, in the service of Congress, until he resigned some years later to devote himself to scientific work. He was succeeded by Mr. John Murdoch, and on his resignation, in 1892, the present incumbent, Doctor Cyrus Adler, was appointed librarian.

The advantages confidently anticipated from the conjunction of the two libraries in the Capitol, although accompanied by some serious drawbacks hereafter referred to, have been in great measure realized. The Smithsonian collection, so rich in the transactions and other publications of scientific bodies throughout the world, formed a specially extensive and invaluable complement to the already large miscellaneous Library of Congress. The benefit to scientific students and to the public of finding in one central repository so extensive a collection of aids to research, without traveling to widely separated localities to pursue their investigations, can hardly be overrated. Economy of time, convenience of readers, comprehensiveness of authorities, were all united in contributing to the objects aimed at in such researches. No class of men can be more impressed than scholars with the supreme value of moments. The ideal university of modern times is a library of universal range, in which the books shall come to the reader as fast as wanted, without troubling the reader to travel after the books. That concentration of mind and of pursuit which is the secret of success in so many fields is signally furthered by bringing all aids to research to one common center.

That an ideal so much to be desired has not yet been attained in the government library in Washington is due to several causes which may be briefly summarized. They all concenter in one pregnant fact — utterly inadequate space within the Capitol for the reception and arrangement of a great comprehensive library. Within two years after the completion of the two library wings referred to, they were nearly filled by the accession, first, of the large historical library of Peter Force, and, secondly, by the reception of the Smithsonian collection. Every step in the internal economy of the library in the thirty years following has been a study

of providing for an overflow. All available space within the library having been exhausted by the introduction of movable cases of shelves, storage-rooms in the basement of the Capitol were next availed of. To add to the embarrassment, although directly contributing to the enrichment of the library, the copyright law was enacted in 1870, by which all records of copyright were thenceforth to be concentrated in the office of the Librarian of Congress, and two copies of all publications under that law to be there deposited. This provision has entailed an enormous increase of library material, consisting not only of books and periodicals, but of a great variety and quantity of maps and works of graphic art, and musical compositions, occupying large space, and pouring in year by year in a constantly increasing flood. Thus the very means which most powerfully contributes to increase the library also adds incalculably to the difficulties of its accommodation and arrangement in the extremely narrow space provided. The evils of overcrowding, and the hopelessness of any remedy within the walls of the Capitol, were urged upon Congress year after year by the librarian, and by enlightened members of both Houses of Congress. In his annual report for 1877, *instar omnium*, this language was used by the librarian:

"While it may be said in extenuation that it is no function of the Library of Congress to supply the public, whether residents of Washington or the scholars of the country, with facilities for information, it cannot be forgotten that Congress has itself invited such frequentation by the liberal policy of accumulating a great library at the seat of government, and throwing open its doors to all. It has also taken in charge the rich scientific library of the Smithsonian Institution, as a probably permanent deposit, with the contingent responsibility of making its stores contribute to the diffusion of knowledge among men. And it would little comport with the

theory or the practice of our popular institutions and form of government that any new bars should be placed in the path of the widest diffusion of intelligence. When it is considered that, from the nature of the case, the embarrassment of producing books and information from these accumulated heaps is constantly growing; that Congress, by the act of 1870, requiring two copies of every publication protected by copyright to be deposited in the library of the government, settled the question of its possible permanent shelter in the Capitol in the negative; that this building, overcrowded in all its departments so that several committees have to occupy the same room, is crowded worst of all in the library department, to which no possible outlet or addition of room can be procured; that the mere arithmetical computation of the growth of the country's literature proves that space must be provided within the century for a building at least two thirds the size of the Capitol; that there is no large capital in Europe in which the library of the government can be or is provided for under the same roof with its legislature; that in our case, and in ours alone, there is added to the great government library the extensive and growing bureau of copyrights and copyright business for the whole country; that the attempt to get along with this double difficulty has already produced great injury to the books, with partial exclusion from their benefits, and must ultimately curtail the usefulness of the library to an incalculable degree; that even if the remedy authorizing new space to be provided were immediately applied, some years must elapse before the requisite building accommodations could be complete: the case becomes one of such pressing emergency, not to say distress, that argument upon it should be unnecessary. Suffice it to say that it scarcely becomes a government representing a nation of such wealth, intelligence, and power to treat the assembled stores of literature and art of the country, which its own laws have caused to be gathered at the Capitol and thrown open to the people, with such indignity as to subject them to injury and destruction, or to equally reprehensible exclusion from their benefits. Of the mode and

manner of providing for the care and permanent preservation of this treasury of knowledge, Congress is properly the sole judge; but should another session of that body be suffered to pass without proper provision being in some way made for its protection, Congress will hardly be held to discharge the trust reposed in it as the custodian of what President Jefferson called, with prophetic wisdom, "the Library of the United States."

The provision for a library building, a want so pressing and so universally acknowledged, was deferred from year to year by difficulties and dissensions about a site, about plans, about architects, and about cost, until in 1886 an act was passed for the construction of a fire-proof edifice of ample dimensions, upon ground adjacent to the Capitol. The new building, which is recognized as a model of architectural and artistic beauty, and in its interior arrangements is adapted to the highest utility and facility of administration, was completed for occupation in the spring of 1897. In the final and long-deferred result, Congress acted with praiseworthy and far-sighted liberality, and erected a fitting home for the nation's books in this noble temple dedicated to literature, science, and art.

In the new library edifice ample shelf-room is provided for the Smithsonian Library collections, and a spacious room adjoining the eastern book-stack will be placed at the disposal of the secretary for occupancy as an office, or record and reception room.

In its new and commodious quarters it is expected that the complete and thorough arrangement of the Smithsonian books upon the shelves, allowing an adequate space for expansion, will be followed by completion of the catalogue and by the binding for ready use of all completed serials and other works in the collection. Thus the utility of the

Smithsonian Library will be immeasurably increased, every volume being rendered immediately available, instead of being piled in compulsory disorder upon the floors, in the absence, for years past, of any shelves to arrange and classify them. And the conjunction of the great library of reference in the reading-room of the public library adjoining will enable all students, in whatever department of science, or literature, or art, to prosecute their investigations with every facility close at hand. The Smithsonian Institution will for the first time be enabled to secure for its rich collections in scientific knowledge a maximum benefit to the world of readers who will resort to it for instruction in years that are to come.

APPENDIX

APPENDIX

PRINCIPAL EVENTS IN THE HISTORY OF THE INSTITUTION

COMPILED BY WILLIAM JONES RHEES

1826

Oct. 23, James Smithson's will made.

1829

June 27, Death of James Smithson in Genoa, Italy.

1835

July 28, United States Government advised that it was entitled to bequest of Smithson.
Dec. 17, Congress notified by President Jackson of the bequest.

1836

July 1, Act passed by Congress authorizing appointment of agent to prosecute claim of the United States for the legacy.
July 11, Richard Rush appointed agent to prosecute the claim of the United States to the bequest of Smithson.
Nov. 14, Richard Rush, as agent for the United States, entered suit in the British Court of Chancery to obtain possession of the bequest.

1837

Feb. 1, First hearing of the suit before Court of Chancery in London.

1838

May 9, Chancery suit decided in favor of the United States.
June 5, Smithson bequest transferred to Mr. Rush.
Sept. 1, Smithson's personal effects deposited with Collector of Port of New York.
Sept. 1, Bequest deposited in the United States Mint in Philadelphia.
Dec. 6, President Jackson announced to Congress the receipt of the Smithson bequest and asked for adoption of a plan to carry out the intentions of Smithson.

1841

July 12, Minerals, books, manuscripts, and other articles forming part of the Smithson bequest deposited in Patent Office by the Secretary of the Treasury.

1846

Feb. 28, Bill passed House of Representatives organizing the Smithsonian Institution.
Aug. 10, Act of organization of Smithsonian Institution passed by Senate.
Aug. 10, Act of Congress organizing the Smithsonian Institution approved by President Polk.
Sept. 7, First meeting of the Board of Regents held, at which George M. Dallas was elected Chancellor of the Institution.

Dec. 3, Joseph Henry elected Secretary of the Institution.
Dec. 4, Board of Regents adopted a plan of organization for the Institution.
Dec. 23, Site for the Smithsonian building selected.

1847

Jan. 26, Board of Regents "requested the Secretary to nominate an assistant who shall be librarian." The Secretary nominated Charles C. Jewett for Assistant Secretary acting as librarian, who was then elected.
Jan. 28, Plans of Architect James Renwick, of New York, for the Smithsonian building adopted.
Feb. 5, Publication authorized by Regents of "Hints on Public Architecture," by Robert D. Owen, a work chiefly descriptive of the Smithsonian building.
Feb. 25, Lectures "On the construction and use of the Rosse telescope," by William Scoresby, begun in Odd Fellows' Hall, being the first delivered under the auspices of the Institution.
March 19, Contract for construction of building awarded.
April 17, Work begun on laying out and beautifying the grounds (nineteen acres) by planting trees and shrubs, and erection of fences.
May 1, Corner-stone of the Smithsonian building laid.
Sept. 9, Seal of the Institution, with likeness of James Smithson, adopted.
Dec. 13, Program of organization proposed by Secretary Henry adopted.

1848

Aug. 1, Collection of chemical and physical apparatus of Robert Hare presented by him to the Institution.
Aug. 12, Act for the improvement and care of the Smithsonian grounds by the Government, passed by Congress.
Dec. 1, "Ancient Monuments of the Mississippi Valley," the first volume of the Smithsonian Contributions to Knowledge published and distributed. It was decided that no copyright should be taken of the publications.
July 1, System of meteorological observations established, in connection with which it was proposed by Secretary Henry to use the magnetic telegraph in the investigation of atmospherical phenomena, and the notice of approaching storms given to distant observers.

1849

March 7, Vice-President Millard Fillmore elected Chancellor.
April 6, Course of four lectures on "Modern Athens" by Professor Koeppen of Denmark begun. They were delivered in Carusi's Hall.
April 10, East wing of the building completed and occupied by the lecture-room and laboratory, and apparatus rooms.
April 10, Library transferred to eastern range of the Smithsonian building from the Patent Office.
April 30, Course of six lectures on "Geology" by Edward Hitchcock begun; being the first given in the building of the Smithsonian Institution.
System of international exchanges inaugurated.
May 11, Reports on the progress of science begun.
June 27, Appropriation made for collections in natural history.
Aug. 1, First meeting of the "Establishment of the Smithsonian Institution" held, President Zachary Taylor in the chair.

1850

Jan. 22, Explorations under the auspices of the Institution, or aided by its funds, instituted, especially in Oregon, California, and Mexico.
July 5, Nomination by Secretary Henry of Spencer Fullerton Baird as Assistant Secretary in the Department of Natural History, to take charge of the Museum and aid in the publications, etc., approved by the Regents.
Sept. 30, Smithsonian grounds laid out anew, under the direction of Andrew J. Downing.
Dec. 31, East and west wings and ranges of the building finished, and the lecture-room enlarged in the east wing so as to accommodate one thousand persons.

1851

Jan. 7, Chief Justice Taney elected Chancellor.
Jan. 18, Memorial to Congress presented by the Regents asking permission to increase the permanent Smithsonian fund to $715,000.
Dec. 31, Exterior of the Smithsonian building, including the towers, completed.

1852

Feb. 14, British Government admits free of duty, books, etc., sent by the Smithsonian Institution to libraries in England.

1853

Feb. 3, Magnetic observatory on the Smithsonian grounds authorized by the Board of Regents.

March 3, Congress appropriated $3000 to begin preparation of a catalogue of its library on the Smithsonian stereotype plan proposed by Charles C. Jewett.

March 12, Alteration ordered in the east wing of the building to convert it into a residence for the Secretary.

March 12, Resolutions adopted by the Board of Regents referring the subject of the distribution of the income of the Institution to a Select Committee.

June 15, Distribution of duplicate specimens to other museums begun.

1854

Jan. 28, District of Columbia Court decided that the Board of Regents could not be sued.

May 20, Special committee of the Board of Regents reported. "The law is declaratory and positive in charging the Secretary with the enumerated duties, and therefore invests him and him alone with the corresponding powers. . . . He is not *required* to employ any one, but is permitted to employ persons to assist him, provided he satisfy the Board that their services are necessary as aids to him. This view of the intention of Congress so clearly expressed in the law would be directly contradicted by the plan which has been suggested of organizing the Institution definitely into several departments, placing at the head of these departments different assistants, establishing their relative positions, describing distinct duties for them, assigning certain shares of the income to be disbursed by them, and stating their authorities, privileges and remedies for the infringement of their official rights or of the interests entrusted to their care. All this would tend not to secure a loyal and harmonious coöperation, to a common end, of the assistants with the Secretary, but to encourage rivalry, to invite collision, to engender hostility, to destroy subordination, to distract the operations of the Institution, to impair its efficiency and to destroy its usefulness."

July 8, Preamble and resolution from the Select Committee adopted as follows:
"The Secretary of the Institution and of this Board is, by the seventh section of the Act 'to establish the Smithsonian Institution,' required to discharge the duties of 'librarian and Keeper of the Museum, having, with the consent of the Board of Regents, power to employ assistants, the better to enable him to discharge those duties; for a better construction whereof—*Be it resolved*, that whilst power is reserved in the said section to the Board of Regents to remove both the Secretary and his assistants, in the opinion of the Board, power, nevertheless, remains with the Secretary to remove his said assistants."

December, Main portion of the Smithsonian Building completed.

1855

Jan. 12, Resolutions of the Select Committee adopted, repealing the equal distribution of the income and providing that appropriations should be specific.

Jan. 13, Secretary Henry, at meeting of Board of Regents, stated that he had deemed it his duty to remove Charles C. Jewett from the office of Assistant to the Secretary.

Jan. 13, Rufus Choate resigned his office of Regent, stating that he had done so because of his inability to acquiesce in the interpretation, by a majority of the Board, of the Act of Congress organizing the Institution.

Jan. 13, Judiciary committee of the Senate instructed to inquire and report whether any action of the Senate was necessary and proper in regard to the Smithsonian Institution.

Jan. 15, The following resolutions were adopted by the Board of Regents:
"*Resolved,* That while the Board regret the necessity of Mr. Jewett's removal, they approve of the act of the Secretary.
"*Resolved,* That the approval by the Board is not deemed by them to be essential to the validity of the act of the Secretary in so removing Mr. Jewett."

Jan. 17, Mr. Choate's letter of resignation was referred, in the House of Representatives, to a Special Committee of five, to inquire into the management of the Institution, and with power to send for persons and papers.

Jan. 26, Committee of the House called upon Secretary Henry and on other officers of the Institution for a statement of their acts, investigated the claim of an employee for additional remuneration for services, etc.

Feb. 6, Unanimous report of the Senate Judiciary Committee served to establish the legality of the action of the Regents, and the policy of the Board has since been continued without objection, in the same line as that which was originally marked out by Henry when he accepted the secretaryship of the Institution in 1846.

Feb. 24, Board of Regents "resolved that all correspondence of the Institution shall be conducted by the Secretary, and no assistant or employee shall write or receive any official letter or communication pertaining to the affairs of the Institution, except under the authority and by the direction of the Secretary, and all such correspondence shall be duly registered and recorded."

March 3, Numerous meetings of the House Committee were held, and finally two reports were presented, with the testimony taken.

March 3, Act passed by Congress allowing all copyright publications to be sent to the Institution free of postage.

March 3, Annual report for 1854 ordered by Congress, being the first to contain the lectures, extracts from the correspondence, and miscellaneous papers in the form of a General Appendix.

1856

March 8, Free transportation of freight granted to the Institution by the Mexican Gulf, Pacific Mail, South American, and United States Mail Steamship Companies, and by the Panama Railroad Company.

September, Monument erected in Smithsonian Park to the memory of Andrew Jackson Downing, architect and landscape gardener.

1857

March 3, Congress appropriated $2000 for the transfer of the collections of the Government from the Patent Office to the Institution, and $15,000 for the construction of cases.

March 31, Personal effects of James Smithson removed from the Patent Office and deposited in the Regents' room at the Institution.

1858

May 19, Special committee of the Board of Regents made a report relative to Joseph Henry's connection with the invention of the electro-magnetic telegraph.

June 2, Congress appropriated $4000 for care of the Government collections, and $1000 for transfer from the Patent Office.

Aug. 8, Government collections were transferred from the United States Patent Office to the Institution.

Daily weather-map, from telegraphic reports received every morning at 10 o'clock, exhibited in the Smithsonian building.

1859

Jan. 25, Free transportation granted to the Institution by the North German Lloyd steamers.

Feb. 5, Congress amended copyright law, and on the recommendation of the Board of Regents repealed the requirement that copies of all copyrighted books, maps, charts, etc., be sent to the Institution.

1860

Feb. 25, Free transportation of freight granted by the Cunard Steamship Line to England.

Dec. 31, Magnetic observatory discontinued, and the instruments sent to Fort Taylor, Key West, in care of the tidal station of the United States Coast Survey.

1861

June 13, Balloons sent up from the Smithsonian grounds by Thaddeus S. C. Lowe, to test practicability of their employment for military purposes.

Oct. 21, Free transportation of freight granted by the Hamburg-American Packet Company.

1862

Feb. 28, Institution coöperated with Surgeon-General of the United States Army, and with Sanitary Commission, in the improvement of the health and comfort of the soldiers during the civil war.

April 15, Daily telegraphic bulletin of the weather, which had been discontinued for some time on account of the demands of public business, partially resumed.

June 2, Series of publications in octavo called "Smithsonian Miscellaneous Collections" begun.

July 27, Charter of the National Institute expired, and in accordance with its act of incorporation its property was delivered by Secretary of the Interior to Smithsonian Institution.

1863

March 3, Congress having incorporated the National Academy of Sciences, rooms were furnished to it by the Institution for its meetings and library.

1864

June 11, Residuary legacy of Smithson, on account of the death of the annuitant, Madame La Batut, received by the Institution.

Aug. 1, Application made to the North American Telegraphic Association, covering the entire United States and Canada, for free use of its lines for the scientific objects of the Institution, which was subsequently granted.

1865

Jan. 9, Chief Justice Salmon P. Chase elected Chancellor.

Jan. 10, Act establishing the Institution amended by Congress, repealing the section that required two of the Regents to be members of the National Institute in the city of Washington.

Jan. 24, Fire destroyed the principal part of the contents of the rooms in the upper story of the Smithsonian building and the adjacent towers, including the personal effects of Smithson.

July 1, Reconstruction of the building with fireproof materials begun, in accordance with the plans and under the superintendence of Adolf Cluss, architect.

1866

April 5, Act passed by Congress transferring the custody of the library of the Smithsonian Institution to the Library of Congress.

1867

Feb. 8, Act passed by Congress providing that the residuary legacy of Smithson should be received and added to the Smithson Fund, and allowing the Regents to increase that fund in the Treasury of the United States by savings, donations, and otherwise, to one million dollars.

March 2, Act passed by Congress to provide for fifty copies of all documents printed by either House of Congress, or by any Department or Bureau, to be exchanged through the agency of the Smithsonian Institution for similar works published in foreign countries, and especially by foreign governments.

1868

Jan. 1, National Herbarium transferred to the Department of Agriculture.

July 25, Amendment to the law relative to the exchange of documents with foreign governments passed by Congress.

1869

July 7, West range of the Smithsonian building, in addition to the main halls, assigned to the use of the Museum.

1870

June 1, Secretary Henry visited Europe in behalf of the interests of the Institution, and testified before an English government Scientific Commission regarding the objects and methods of the Institution.

Aug. 8, Secretary Henry represented the United States, by appointment of President Grant, at the International Commission invited by the Emperor of France to

consider the best means of multiplying copies, for distribution, of the original meter preserved in the archives of the government in Paris.

Oct. 20, Leonard Case, of Cleveland, Ohio, contributed $1200 in aid of publications.

1871

Feb. 25, Spencer F. Baird, Assistant Secretary of the Institution, appointed United States Commissioner of Fish and Fisheries by President Grant.

March 3, Appropriation for continuing the survey of the Colorado River of the West by John W. Powell, under direction of the Secretary of the Smithsonian Institution, made by Congress.

March 15, Act establishing the Institution amended by Congress, by substituting the "Governor of the District of Columbia" for the "Mayor of the City of Washington," as one of the Regents *ex officio* of the Institution.

Nov. 20, James Hamilton, of Carlisle, Pennsylvania, made a will bequeathing $1000 to the Institution.

1872

June 8, Law passed by Congress that "all publications sent or received by the Smithsonian Institution, marked on each package, 'Smithsonian exchanges,' shall be allowed to pass free in the mail."

July 9, Collection of minerals, ores, and geological specimens which had been formed by Joseph Wilson, Commissioner of the General Land Office, embracing samples from every State and Territory in the Union, transferred to the Institution by the Secretary of the Interior.

1873

Jan. 20, Various ocean cable and inland telegraph companies granted the Institution the privilege of transmitting without charge, between Europe and America, announcement of astronomical discoveries.

June 18, Exchange of sets of United States Government documents with foreign governments begun.

Dec. 19, Justice Nathan Clifford elected Chancellor.

Dec. 31, Smithsonian meteorological work transferred to the signal office, War Department, under "the policy that the Institution should devote its energies to no field of research which can be as well cultivated by other means."

1874

Jan. 1, Annual income and receipts of the Institution deposited with the Treasurer of the United States, who makes payments on checks signed by the Secretary.

Jan. 26, Secretary authorized by Board of Regents to receive aid from societies and individuals in defraying part of the expense of the exchange system.

Feb. 13, Paintings, statuary, engravings, and books on art belonging to the Institution deposited in the Corcoran Art Gallery.

Feb. 24, Bequest of James Hamilton of $1000 deposited in United States Treasury to credit of Smithson fund.

March 25, Assistant Secretary Spencer F. Baird appointed by the President a member of the Government Board for the Centennial Exhibition to be held in Philadelphia.

April 27, Chief Justice Waite elected Chancellor.

1875

March 3, Act passed by Congress extending the use of the Library of Congress to the Regents of the Institution.

March 3, Appropriation by Congress to aid in making an exhibit at the Centennial Exhibition in Philadelphia.

Nov. 23, A series of publications entitled "Bulletin of the United States National Museum" begun.

1876

July 31, Use of the Armory Building in the Mall granted by Congress for temporary storage of collections received from the Centennial Exhibition.

Oct. 18, Medals, etc., awarded by the United States Centennial Commission to the Smithsonian Institution for certain of its exhibits in the Exhibition in Philadelphia.

1878

May 13, Death of Joseph Henry, Secretary of the Institution.

May 17, Spencer F. Baird elected Secretary.

June 12, Telephones introduced.
Dec. 15, East wing of the Smithsonian building converted into offices and work-rooms.

1879

Jan. 16, Memorial services in honor of Secretary Henry held in the U. S. Capitol.
Jan. 24, Act passed by Congress authorizing the Chancellor of the Smithsonian Institution to appoint an acting Secretary in certain cases.
March 15, Bequest of $500 received from Doctor Simeon Habel of New York.
March 3, Congress appropriated $250,000 for a fireproof building for the National Museum.
March 3, All official mail matter sent from the Smithsonian Institution allowed transmission free of postage by Act of Congress.
March 3, Congress ordered "all the archives, records, and materials relating to the Indians of North America, collected by the Geographical and Geological Survey of the Rocky Mountain Region, turned over to the Smithsonian Institution, that the work may be completed and prepared for publication under its direction."
March 3, Congress provided that books or documents from the Smithsonian Institution should not be restricted to four pounds for each package to be sent through the mails as fourth-class matter.
March 3, Congress ordered "all collections of rocks, minerals, soils, fossils, and objects of natural history, archæology and ethnology made by the Coast and Interior Survey, the Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress, to be deposited in the National Museum."
July 3, Secretary Baird designated John W. Powell to take charge of the Ethnological work, as provided by Congress.
Aug. 1, Series of publications entitled "Proceedings of the National Museum" begun.

1880

June 1, Congress appropriated $15,000 for a bronze statue of Professor Joseph Henry, by W. W. Story.
June 14, First report of the Bureau of Ethnology ordered to be published by Congress.

1881

March 4, Reception and ball in connection with inauguration of President Garfield held in the National Museum building.
Sept. 1 to Sept. 30, Smithsonian Institution participated in the International Geographical Congress in Venice.
Sept. 15 to Oct. 5, Smithsonian Institution participated in the International Electrical Congress in Paris.
October, Smithsonian National Museum Building occupied.

1882

Jan. 4, Midshipmen of the United States Navy assigned by the Navy Department to the temporary service of the National Museum.
Nov. 3, Smithsonian Institution made a co-partner in the administration of a beneficiary trust of a million dollars by Reverend Alexander G. Mercer, of Newport, Rhode Island, a Board being constituted of the Presidents of Harvard College, and Yale College, and the Secretary of the Smithsonian Institution, with three other individuals, to establish scholarships in such colleges as they may select for the education of "such poor students as have passed through public schools with the best reputation for character and ability."

1883

Jan. 10, System of telegraphic announcement of astronomical discoveries inaugurated by the Institution in 1873 transferred to Harvard College Observatory.
March 3, Congress appropriated $50,000 to reconstruct in a fire-proof manner the eastern portion of the Smithsonian building.
April 19, Bronze statue of Joseph Henry erected in the Smithsonian grounds by order of Congress, unveiled.
May 1 to Nov. 1, National Museum participated in International Fisheries Exhibit in London.
May 19, Washington relics transferred from Patent Office to National Museum.
July 1, Publication of the Bulletin and Proceedings of the National Museum discontinued as parts of the series of "Smithsonian Miscellaneous Collections," and ordered to be carried on independently.
July 23, Electric lighting introduced in Museum.

1884

May 13, Act passed by Congress to provide for the appointment of an Acting Secretary of Smithsonian Institution.

July 5, Franking privilege extended to all official mail matter of Smithsonian Institution by order of Congress.

Sept. 2, Participation in the International Electrical Exhibition in Philadelphia, Pa.

Participation in the Louisville, Kentucky (*August 16–October 25*), and Cincinnati, Ohio (*September 3–October 4*), and New Orleans, Louisiana (*December 16*, 1884, to *May 31*, 1885) Expositions.

1885

Jan. 21, Regents decided that "the fiscal year of the Institution shall terminate on the 30th of June of each year, and that the annual meeting of the Board of Regents shall be held on the second Wednesday of January in each year."

March 3, By order of Congress, "The annual reports of the Institution shall be hereafter printed at the Government Printing Office, in the same manner as the annual reports of the Heads of Departments are now printed, for submission in print to the two Houses of Congress."

1886

Aug. 5, Congress ordered the Grant medals and objects of value and art to be deposited in National Museum.

1887

Jan. 12, Secretary Baird appointed Samuel P. Langley as Assistant Secretary in charge of Exchanges, Publications, and Library, and G. Brown Goode as Assistant Secretary in charge of the National Museum, which appointments were approved by the Board.

March 3, Congress provided that the Secretary of State, the Librarian of Congress, and the Secretary of the Smithsonian Institution, and their successors in office, be constituted a Commission, whose duty it shall be to report to Congress the character and value of the historical and other manuscripts belonging to the Government of the United States, and what method and policy should be pursued in regard to editing and publishing the same, or any of them.

April 1, New regulations made by the Secretary for the library, and efforts begun to complete imperfect sets of transactions of learned societies and to increase the number of periodicals in all departments of knowledge.

July 7, "The Director of the National Museum directed to report annually to Congress the progress of the Museum during the year, and its present condition."

Aug. 19, Death of Spencer F. Baird, Secretary of the Institution.

Aug. 31, Participation in the Minneapolis Industrial Exposition.

Nov. 18, Samuel P. Langley elected Secretary.

1888

Jan. 11, Regents decided that all estimates for appropriations should be sent direct by the Secretary of the Institution to the Secretary of the Treasury for transmission to Congress.

Oct. 4, Disbursing Officer was appointed, duly qualified and bonded to the acceptance of the Secretary of the Treasury, for the disbursement of all sums appropriated by Congress to the Smithsonian Institution for the National Museum, Exchanges, Bureau of Ethnology, Zoölogical Park, and Astrophysical Observatory.

March 27, Justice Samuel F. Miller elected Chancellor *pro tem.*

July 4 to Oct. 7, Participation in the Ohio Valley and Central States Exposition in Cincinnati, Ohio, and

July 16–21, the Marietta Exposition, Marietta, Ohio.

Oct. 2, Congress ordered that the Secretary of the Smithsonian Institution should submit at the beginning of each session a detailed statement of expenditures of the appropriations of the several bureaus under its direction.

1889

Jan. 4, American Historical Association incorporated by Congress and ordered to report annually to the Secretary of the Smithsonian Institution, who shall communicate the whole or parts of such reports to Congress; the collections, manuscripts, books, pamphlets, and other material for history to be deposited in the Smithsonian Institution or National Museum.

Jan. 9, Chief Justice Melville W. Fuller elected Chancellor.
March 2, National Zoölogical Park established by an Act of Congress.

1890

Jan. 8, Time of annual meeting ot Board of Regents changed to the fourth Wednesday in January.
March 1, Astrophysical Observatory established in a wooden edifice built at the cost of the Smithsonian Institution, on the grounds south of the Smithsonian building.
April 26, Bequest of Jerome H. Kidder of $5000 and June 5 a gift from Alexander Graham Bell of $5000 for astrophysical research received.
April 30, National Zoölogical Park placed under the direction of the Regents of the Smithsonian Institution by order of Congress.
Aug. 30, Congress appropriated $25,000 to make the west wing of Smithsonian building fireproof.

1891

March 3, First appropriation ($10,000) made for the maintenance of the Astrophysical Observatory by Congress.
Sept. 22, Gift of $200,000 received from Thomas G. Hodgkins of Setauket, New York.

1892

Oct. 31, 1892, to Jan. 31, 1893, Participation in the Columbian Historical Exposition in Madrid.
Nov. 25, Death of Thomas G. Hodgkins, who left by will additional gifts to the Institution.

1893

Jan. 25, New seal, designed by A. St. Gaudens, adopted by the Institution.
May 1 to Oct. 31, Participation in the World's Columbian Exposition in Chicago.
June 1, Study table maintained at the Naples Zoölogical Station for occupancy by a student in Biology designated by the Smithsonian Institution.
Oct. 25, Received $42,000 West Shore Railroad four per cent bonds from bequest of Thomas G. Hodgkins.

1894

March 12, Act amending Revised Statutes, title 73, relative to constituent members of the "Establishment," and providing that the Institution may have power to receive money or other property by gift, bequest, or devise, passed by Congress.
May 19, An additional sum of $8000 received from the Hodgkins estate.
July 28, National Herbarium recalled from the Department of Agriculture.
Sept. 12, Death of Robert Stanton Avery, who bequeathed his property to the Institution.

1895

Jan. 28, Hamilton Fund increased to $2000 by deposit of accrued interest, in the United States Treasury.
Aug. 9, Award of prizes from the Hodgkins Fund made.
Sept. 18 to Dec. 31, Participation in the Cotton States and International Exposition in Atlanta, Georgia.
Dec. 25, Complete set of the publications of the Institution deposited in the Library of Pembroke College, Oxford, the college from which Smithson was graduated.

1896

June 18, President of the United States directed the application of the Civil Service rules from July 1, 1896, to all persons in the Bureaus under the Institution whose salaries are paid out of government appropriations.
July 18, Paintings, engravings, and other art works, deposited in the Corcoran Gallery ot Art in 1874 and later, returned to the Institution at the request of the Regents.
Sept. 6, Death of G. Brown Goode, Assistant Secretary of the Smithsonian Institution, in charge of the National Museum.
Nov. 18, Bronze tablet directed to be placed on Smithson's tomb by the Institution, and a replica in the English Church in Genoa, Italy.

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